Arctic Char, *Salvelinus alpinus*, Sport Fishery of Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002 and 2004

J.A. Babaluk, J. Ohokannoak, K. Schlosser, R.J. Wastle, and R. Bajno

Central and Arctic Region
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB R3T 2N6

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ARCTIC CHAR, *Salvelinus alpinus*, SPORT FISHERY OF NALUSIAQ LAKE, AUYUITTUQ NATIONAL PARK, NUNAVUT, MAY 2002 and 2004

by

J.A. Babaluk, J. Ohokannoak[1], K. Schlosser[1], R.J. Wastle, and R. Bajno

Central and Arctic Region

Fisheries and Oceans Canada

501 University Crescent

Winnipeg, MB R3T 2N6

[1]Parks Canada, Nunavut Field Unit, P.O. Box 278, Iqaluit, NU X0A 0H0

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TABLE OF CONTENTS

	Page
ABSTRACT/RESUMÉ	viii
INTRODUCTION	1
MATERIALS AND METHODS	2
Study area	2
Creel census	2
2002	2
2004	3
Data analysis	3
Biological evaluation	3
2002	3
2004	4
Data analysis	4
Otolith microchemistry	5
Otolith preparation	5
Electron microprobe analysis	5
Genetics	6
RESULTS AND DISCUSSION	7
Creel census	7
Biological evaluation	9
Size composition of the catch	9
Age composition of the catch	11
Growth	13
Gill rakers	16
Otolith microchemistry	16
Arctic char of known life histories	16
Nalusiaq Lake Arctic char of unknown life histories	17
Genetics	21
ACKNOWLEDGMENTS	21
REFERENCES	21

LIST OF TABLES

Table		Page
1	Ranges of otolith Sr concentrations for select anadromous, freshwater and marine fish species	27
2	Microsatellite primers used in this study	28

Table		Page
3	Summary of creel census information from the Qikiqtarjuaq fishing derby at Nalusiaq Lake, May 2002	29
4	Summary of creel census information from the Qikiqtarjuaq fishing derby at Nalusiaq Lake, May 2004	30
5	Comparison of gill raker counts from several Arctic char populations in the Canadian Arctic	31
6	Genetic data at 11 microsatellite loci and the sequence haplotypes for mitochondrial DNA (mtDNA) control region's left and right domains	32

LIST OF FIGURES

Figure		
1	Map of the Nalusiaq Lake area, Auyuittuq National Park, Baffin Island, Nunavut showing the lake where the fishing derby was held	33
2	Photograph of an Arctic char showing areas where samples were collected (otoliths, adipose fin, gill arch) and measurement (fork length) was made	34
3	Typical Arctic char otolith showing the a) lateral side of its external surface; dashed lines indicate the transverse section taken to expose the internal surface for electron microprobe analysis and b) exposed surface of the otolith section showing typical transects (dotted lines) along which the analyses were conducted	35
4	Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	36
5	Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004	37
6	Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	38
7	Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004	39
8	Relationship between fork length and age for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	40
9	Relationship between fork length and age for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004	41

Figure		Page
10	Relationship between weight and fork length for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	42
11	Relationship between weight and fork length for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004	43
12	Typical strontium distribution profiles from scanning proton microprobe line-scans of an otolith collected from (a) a known non-anadromous Arctic char from Kilbourne Lake (Quttinirpaaq National Park, Ellesmere Island, Nunavut) and (b) a known anadromous Arctic char from Halovik River (Victoria Island, Nunavut)	44
13	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#49013, 452 mm, 830 g, female, 9+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	45
14	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48964, 406 mm, 690 g, male, 8+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	46
15	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48966, 595 mm, 2260 g, female, 17+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	47
16	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48970, 389 mm, 560 g, male, 7+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	48
17	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48981, 595 mm, 2260 g, female, 15+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	49
18	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48982, 676 mm, 3260 g, male, 21+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	50
19	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48989, 516 mm, 1590 g, female, 12+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	51

Figure		Page
20	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48979, 415 mm, 760 g, female, 12+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	52
21	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48996, 745 mm, 3200 g, male, 21+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	53
22	Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#49036, 622 mm, 2590 g, male, 15+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002	54

LIST OF APPENDICES

Appendix		
1	Information pamphlet provided to 2004 Qikiqtarjuaq fishing derby participants by derby organizers	55
2	Field sample and laboratory processing numbers, fork lengths, weights, sex, otolith ages, and condition factors for Arctic char captured in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002	56
3	Field sample and laboratory processing numbers, fork lengths, weights, sex, otolith ages, and condition factors for Arctic char captured in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	59
4	Biological data by length interval for Arctic char angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002	62
5	Biological data by length interval for Arctic char captured at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	63
6	Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	64
7	Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males gillnetted at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	65
8	Biological data by age group for Arctic char angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002	66

Appendix		Page
9	Biological data by age group for Arctic char captured at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	67
10	Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	68
11	Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males gillnetted at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004	69

ABSTRACT

Babaluk, J.A., Ohokannoak, J., Schlosser, K., Wastle, R.J., and Bajno, R. 2010. Arctic char, *Salvelinus alpinus*, sport fishery of Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002 and 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2933: ix + 69 p.

During May 2002 and May 2004, creel censuses and biological surveys were conducted on the annual Arctic char, *Salvelinus alpinus*, sport fishing derby held on the Nalusiaq Lake system, Auyuittuq National Park, Nunavut. An estimated 425 fishers took part in the 2002 fishery while an estimated 427 fishers participated in 2004. Fishing pressure decreased from 2002 (1276 angling hours) to 2004 (673 angling hours). However, catch-per-unit-effort increased from 2002 (0.40 fish per hour) to 2004 (0.70 fish per hour). An estimated 510-515 Arctic char weighing a total of 822-830 kg were captured and retained in 2002 while in 2004, 472-474 Arctic char (822-830 kg) were taken. The size range for the 2002 catch was 193-761 mm (fork length) with a mean length of 521 mm. In 2004, sizes ranged from 215-757 mm (mean = 546 mm). The age range for the 2002 catch was 6-21 years (mean = 12.6 years) while in 2004, ages ranged from 5-24 years (mean = 14.3 years). Two growth forms of Arctic char are present in Nalusiaq Lake: a fast-growing large form and slow-growing small form. Micro-chemical analysis of Arctic char otolith strontium distributions indicated an anadromous component to the population. Age-at-first-migration to the sea ranged from 3+ years (fourth year of life) to 6+ years (seventh year of life).

Key words: anadromy; Arctic char; Auyuittuq National Park; biological characteristics; creel census; genetics; otolith microchemistry; sport fishery survey.

RÉSUMÉ

Babaluk, J.A, Ohokannoak, J., Schlosser, K., Wastle, R.J., and Bajno, R. 2010. Arctic char, *Salvelinus alpinus*, sport fishery of Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002 and 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2933: ix + 69 p.

En mai 2002 et à nouveau en mai 2004, nous avons effectué des relevés des prises sportives et des relevés biologiques lors du tournoi de pêche annuel de l'omble chevalier, *Salvelinus alpinus*, tenu dans le réseau du lac Nalusiaq, situé dans le parc national du Canada Auyuittuq, au Nunavut. Quelque 425 pêcheurs ont participé au tournoi de 2002 et 427 à celui de 2004. La pression de la pêche a diminué en 2004 (673 heures de pêche) par rapport à 2002 (1 276 heures de pêche), mais les prises par unité d'effort étaient plus élevées en 2004 (0,70 poisson par heure) qu'elles ne l'étaient en 2002 (0,40 poisson par heure). Selon nos estimations, de 510 à 515 ombles, pesant au total de 822 à 830 kg, ont été capturés et gardés en 2002, et de 472 à 474, pesant de 822 à 830 kg, en 2004. La fourchette des longueurs à la fourche des prises de 2002 allait de 193 à 761 mm (taille moyenne de 521 mm), et celle des prises de 2004, de 215 à 757 mm (taille moyenne de 546 mm). L'intervalle d'âges des prises de 2002 allait de 6 à 21 ans (âge moyen de 12,6 ans), et celui des prises de 2004, de 5 à 24 ans (âge moyen de 14,3 ans). L'omble arctique du lac Nalusiaq présente deux formes de croissance : une forme de grande taille à croissance rapide et une forme de petite taille à croissance lente. Une analyse microchimique de la distribution des concentrations de strontium dans les otolithes d'omble chevalier a révélé la présence d'une composante anadrome dans la

population. L'âge à la première descente vers la mer allait de 3+ ans (quatrième année de vie) à 6+ ans (septième année de vie).

Mots-clés : anadromie; omble chevalier; parc national du Canada Auyuittuq; caractéristiques biologiques; relevé des prises sportives; génétique; microchimie des otolithes; enquête sur la pêche sportive.

INTRODUCTION

Auyuittuq National Park is located in the central, north-eastern portion of Baffin Island, Nunavut (see Fig. 1, upper inset) and with an area of 19,089 km^2, is the sixth largest national park in Canada. The area was first established as a "park reserve" in 1976 and became an official national park in 2001. Arctic char, *Salvelinus alpinus*, is the primary fish species inhabiting lakes within the park. Arctic char is an important subsistence and commercial fish to the Inuit of Qikiqtarjuaq (formerly Broughton Island) (see Fig. 1, upper inset) and the char fishery will most likely remain an important factor in maintaining traditional lifestyles for community residents. The residents of Qikiqtarjuaq have traditionally harvested char from lake and river systems both within and outside the boundaries of Auyuittuq National Park (Read 2000). During the late 1980s and throughout the 1990s, the Nudlung Fiord area, just outside the park (see Fig. 1, lower inset), has been harvested commercially (Department of Fisheries and Oceans 1991, 1999). However, fishing within current park boundaries has been limited in the past and was restricted to the areas of Nedlukseak and Narpaign fiords (Drolet 1978) (see Fig. 1, lower inset). Information on other char populations within the park is presented in Stewart and Bernier (1988). One of the lake systems within the park that residents of Qikiqtarjuaq have traditionally fished is composed of the Nalusiaq lakes (Fig. 1). In 1995-1996, a Department of Fisheries and Oceans (DFO)-licensed experimental fishery was conducted on these lakes to determine the feasibility of establishing a commercial fishery (Department of Fisheries and Oceans 1997). In addition to supporting a food and commercial fishery, the char support a local recreational fishery as well. An annual fishing derby, sponsored by the Nattivak (Qikiqtarjuaq) Hunters and Trappers Organization and Papiruq Fisheries and sanctioned by Parks Canada, takes place in late May in the park usually on the second of the five Nalusiaq lakes (Fig. 1). Participants travel from Qikiqtarjuaq to the lake by snowmobile and komatik and camp there during the weekend of the derby.

Recently, derby participants have expressed concerns that catches from the lake appear to be declining. Parks Canada, with the assistance of DFO, monitored the May 2002 fishing derby with the goal of collecting base-line data on the Arctic char of the lake. The purpose of collecting this information was to assess angling pressure and harvest and to describe briefly some of the biological characteristics of the angled catch. Parks Canada, again with the assistance of DFO, monitored the May 2004 fishing derby with the goal of collecting data on the Arctic char of the lake that could be compared with the data collected two years earlier. This report presents and discusses the creel census and biological data collected from the Arctic char fishing derbies

conducted between May 25-27, 2002 and May 22-24, 2004. In addition, micro-chemical analysis was conducted to measure and determine the pattern of strontium (Sr) distribution in the otoliths of Arctic char from the lake to determine whether the fish were anadromous. Genetic analysis was conducted with that data to be used in the future to assess differences between populations throughout the range of the species.

MATERIALS AND METHODS

STUDY AREA

The study lake is unnamed on Canadian government topographic maps but it has several local names, all most likely derived from nearby Nedlukseak Fiord. When the study was conducted in 2002, the local name provided was Nalusiaq Lake; for the 2004 study, the local name used was Nedlukseak Lake; and on local advertisements for the 2004 fishing derby, the name Nadluqsiaq Lake was used (see Appendix 1). For this report, the name Nalusiaq Lake was used.

The Nalusiaq Lake system (67°51'N, 66°14'W) is made up of a series of five small lakes located between Nedlukseak Fiord and Okoa Bay in Auyuittuq National Park, Baffin Island, Nunavut (Fig. 1). The lakes drain by an unnamed river into the sea at Okoa Bay. The river is ~10 km long with no apparent barriers to fish movement between the lakes and the sea. The area around the lake system is very rugged with steep relief (elevation ranging from sea level to ~1500 m). The lower slopes of the valley around lakes in this area support vegetation but the upper plateau surfaces are barren (Canadian Parks Service 1989). In both 2002 and 2004, the fishing derbies were held on the second of the five lakes in the system (Fig. 1).

CREEL CENSUS

2002

The 2002 Qikiqtarjuaq fishing derby on Nalusiaq Lake was held on May 25-27. Official derby fishing periods were between 0800-2300 h on May 25 and 26 and 0800-1200 h on May 27. Approximately 425 people registered for the derby. All derby fishing was done by jigging with lures through holes in the ice. Some fishing (jigging and gillnetting) continued outside of derby hours but fish caught then were not eligible for derby prizes and no fish caught outside of derby

hours were included in the census or biological evaluation. A partial creel census was conducted (i.e., not all participants were interviewed) on all three days of the derby. Over the course of the derby, 100 interviews were conducted: 66 on May 25, 12 on May 26 and 22 on May 27. No participant was interviewed more than once per day but may have been interviewed more than once (up to three times) over the three-day period. The following information was obtained from each angler interviewed: number of hours spent fishing that day and number of char caught during that time.

2004

The 2004 Qikiqtarjuaq fishing derby on Nalusiaq Lake was held between May 22-24. This was the 10th annual fishing derby (see Appendix 1). Official derby fishing periods were between 0800-2000 h on May 22 and 0800-1200 h on May 24. No official derby fishing was conducted on May 23 as it was set aside as a "feast" day (see Appendix 1 for details). Four hundred and twenty-seven anglers participated in the derby. All derby fishing was done by jigging through holes in the ice. Some fishing (jigging and gillnetting) continued outside of derby hours but fish caught then were not eligible for derby prizes. Over the course of the derby, 66 interviews were conducted (45 on May 22 and 21 on May 24). Similar to 2002, no participant was interviewed more than once per day but may have been interviewed more than once (up to two times) over the two-day period and the following information was obtained from each angler interviewed: number of hours spent fishing that day and number of char caught during that time.

Data analysis

For both years, angler catch per unit effort (CPUE) was calculated as the number of Arctic char caught per angler hour using the following formula:

$$\text{CPUE} = \frac{\text{total number of Arctic char caught by interviewed anglers}}{\text{total number of hours fished by interviewed anglers}}$$

BIOLOGICAL EVALUATION

2002

During the creel census, as many fish as time and angler permission would allow were sampled

for fork length (mm), round weight (g) and sex (n = 100). Due to inclement weather and sampling area conditions, otoliths were not collected in the field. Instead, whole heads of the fish were removed, labelled and frozen. An adipose fin was collected from each specimen and frozen in the field for genetic analysis. Char heads and adipose fins were shipped frozen to DFO in Winnipeg for subsequent processing and analysis. The two sagittal otoliths were extracted from the heads in the laboratory. One of each otolith pair from the sampled char was prepared for age determination by the "break and burn" method described by Chilton and Beamish (1982) and ages were then estimated using the criteria of Kristoffersen and Klemetsen (1991). The second otolith from a select sample of char (n = 10) was prepared for microchemical analysis (see below). Upper and lower arch gill raker counts were also made. In the laboratory, frozen adipose fins were placed in individual vials of 20% DMSO (dimethyl sulfoxide)-NaCl solution and refrozen for genetic analysis (see below). Figure 2 shows where samples were taken on each char examined.

2004

A total of 84 char from the fishing derby were sampled for fork length (mm) and weight (g). Due to a reluctance of some of the derby participants to have their catch further sampled, only 47 of these fish were sampled to determine sex and only 34 of these had otoliths removed. To supplement the char sampled from the fishing derby, a gillnet (4" stretched-mesh, ~25 m long) was set thorough the ice for 8 h on May 24, 2004. The 24 char caught were sampled for fork length, round weight and sex. Otoliths were also collected for subsequent age determinations.

Data analysis

Length, weight and age data were analysed using Microsoft Excel (2002) and SigmaStat (2.0) personal computer software programs and figures were created using SigmaPlot (2000) and CorelDraw (9). For purposes of plotting length-frequency distributions, char from this study were grouped into 50 mm length groups to allow a better comparison with char from the available literature (e.g., Moshenko 1981; Carder 1992).

Weight-length relationships were described by the equation:

$$\text{Log}_{10}W = a + b\ (\log_{10}L)$$

where: W = weight in grams
L = fork length in millimetres
a = Y axis intercept
b = slope of the regression line.

Fulton's relative condition factor (K) was determined from the formula:

$$K = \frac{W \times 10^5}{L^3}$$

where: W = weight in grams
L = fork length in millimetres.

OTOLITH MICROCHEMISTRY

Otolith preparation

One of each of 10 pair of otoliths from the 2002 sample was prepared for wavelength-dispersive electron microprobe analysis. The otoliths were embedded in cold-curing epoxy resin and a transverse cut was made such that a dorso-ventral cross section through the core of the otolith was created, exposing all annuli (yearly growth increments) (Fig. 3a, b). The posterior half of each otolith was then re-embedded with epoxy resin in a standard 25 mm diameter acrylic, geological probe-mount. The exposed otolith surfaces were sequentially ground (30 and 9 μm aluminum oxide lapping film), then polished (5 μm aluminum oxide paste) and finally carbon-coated to prevent charging during microprobe analysis.

Electron microprobe analysis

A photograph of each otolith section was prepared and a linear path (transect) for the microprobe beam was plotted across all growth increments (annuli) from the core to the dorsal edge of the otolith or from the core area running parallel to the sulcus to the outer edge of the otolith (Fig. 3b). The photographs were used as reference "maps" by the microprobe operator.

The wavelength-dispersive electron microprobe used in this study was a Cameca SX-100,

housed at the Department of Geological Sciences, University of Manitoba in Winnipeg, Manitoba. The electron beam was operated at an accelerating voltage of 15 keV and a current of 20 nA. The transects across the otoliths utilized a beam diameter of 5 μm and a center-to-center distance between sequential points of ~7 μm. Strontium (Sr) X-rays were counted at each point for 25 sec. A small pit was left on the otolith surface at every point. Transects, for retrospective determination of life histories, typically consisted of 75 to 175 points, depending on the size of the otoliths and the transect chosen. Strontium values were recorded as percent weight and were converted to parts per million (ppm) (Potts 1987) for comparison to values from the literature. Strontium distribution graphs were then plotted as Sr (ppm) against the number of sample points from the core to the edge of the otolith (i.e., otolith distance).

Using the otolith Sr concentration range information presented in Table 1 as a guide, Nalusiaq Lake Arctic char otolith Sr concentrations were interpreted as follows: 1) 0 to ~1500 ppm as indicative of residence in a freshwater environment, and 2) >~1500 ppm as indicative of fish entering a marine environment, either estuarine or oceanic.

GENETICS

Thirty-four of the 100 Arctic char adipose fin samples collected during the 2002 fishing derby were processed and analyzed to obtain genetic information. Total genomic DNA was extracted from adipose fin tissue using the commercial kit, Genelute™ Mammalian Genomic DNA Miniprep Kit (Sigma-Aldrich Corp., St. Louis, MO, USA).

A total of 941 bases in the control region of the mitochondrial DNA (mtDNA) molecule were sequenced for this study. The control region was amplified by the polymerase chain reaction (PCR) with primers tPro2 (5'-ACCCTTAACTCCCAAAGC-3') (Brunner et al. 2001) and SalpinusCR-R (5'-GGGTCCATCTTAACAGCTTCA-3') (G. Köck, University of Innsbruck, Innsbruck, Austria, personal communication). The target fragment was amplified in a 50 μL reaction containing 10 mM Tris-HCl, 50 mM KCl, 1.75 mM $MgCl_2$, 200 μM of each dNTP, 0.8 μM of each primer, 1 unit *Taq* Polymerase, and approximately 50 ng of DNA. The PCR profile consisted of an initial denaturation at 95° C for 4 minutes followed by 32 cycles of 1 minute at 94° C, 1 minute at 50° C, and 1 minute 30 seconds at 72° C followed by a final extension at 72° C for 10 minutes. An aliquot of the PCR product was visualized under UV light in a 1.5% agarose gel, stained with ethidium bromide. PCR products were purified using the commercial kit QiaQuick® PCR purification kit (Qiagen Inc., Valencia, CA, USA). Due to a long homopolymer

stretch found in the central section of the control region, sequencing was done in two separate segments. The left domain was sequenced with primer Char3 (5'-CCCTATGCATATAAGAGAACGC-3') and the right domain sequenced with amplification primer SalpinusCR-R. Direct sequencing of the PCR product was accomplished using the Applied Biosystems Big Dye® Terminator v3.1 Terminator Cycle Sequencing kit (Applied Biosystems, Foster City, CA, USA). The resulting sequence reaction products were run on an Applied Biosystems 3100 genetic analyzer. Sequences were aligned using Seqscape® v2.5 software (Applied Biosystems, Foster City, CA, USA) and individual haplotypes assigned. Sequences from one representative of each haplotype were verified by sequencing the complementary DNA strand with amplification primer tPro2 for the left domain and primer SalInt (5' - CCTTTCAGCTTGCATATACAAG-3') for the right domain.

DNA samples were also assayed for allelic variation at 11 microsatellite loci (Table 2). One primer from each primer pair was 5' end labelled with one of three fluorescent dyes: 6-FAM (for Sco19, Mst85, Sfo8, and Sfo23), VIC (for Sal38, Sal39, Ssa422, Sal5, and Sal81), and NED (for SaZim72 and Ssa85). Microsatellites were amplified in a 20 µL reaction containing 10 mM Tris-HCl, 50 mM KCl, 3 mM $MgCl_2$, 200 µM of each dNTP, 0.5 µM of each primer, 1 unit *Taq* Polymerase, and ~50 ng of DNA template. Two PCR profiles were used to amplify the microsatellite loci (see Table 2). The first profile consisted of 30 cycles with 30 seconds at 95° C, 30 seconds at the annealing temperature, and 45 seconds at 72° C. The second PCR profile was 10 cycles of 1 minute at 94° C, 1 minute at the annealing temperature, and 50 seconds at 72° C followed by a further 25 cycles of 45 seconds at 90° C, 1 minute at 53° C, and 1 minute at 73° C. Both profiles included an initial denaturation at 95° C for 10 minutes and a final extension of 15 minutes at 72° C. Samples were run on an Applied Biosystems 3100 genetic analyzer. Genemapper® software version 3.7 (Applied Biosystems, Foster City, CA, USA) was used to assign microsatellite alleles.

RESULTS AND DISCUSSION

CREEL CENSUS

Results from the creel census of the 2002 Qikiqtarjuaq fishing derby are presented in Table 3. A total of 100 angler-interviews representing 300.1 hours of angling showed a mean catch rate of 0.40 char per angler hour. One hundred percent of anglers interviewed were successful (i.e.,

each caught at least one char). Over the three days of the derby, there was a general decline in fishing effort: on May 25 anglers spent an average of 4.1 hours fishing; on May 26 this declined to 1.0 hour; and on May 27 a further decline to 0.9 hours was noted. The average number of fish caught by each angler who was interviewed was 1.21 (range = 1.00-1.27).

As approximately 425 people were registered for and took part in the 2002 fishing derby, it was estimated, by extrapolation of the creel census data from 100 interviewed anglers (Table 3), that the harvest of Arctic char over the three-day period was approximately 510-515 fish weighing a total of 822-830 kg. These numbers do not include any char caught and retained from outside official fishing derby hours. The 425 registered anglers exerted a total of 1276 angling hours during the 2002 derby.

Results from the creel census of the 2004 Qikiqtarjuaq fishing derby are presented in Table 4. A total of 66 angler-interviews representing 104.1 hours of angling showed a mean catch rate of 0.70 char per angler hour. Fifty-nine of 66 (89.4%) anglers interviewed were successful (i.e., each caught at least one char). Over the period of the derby, there was a general increase in fishing effort: on May 22 anglers spent an average of 1.4 hours fishing while on May 24 an average of 2.0 hours was noted. The average number of fish caught by each angler who was interviewed was 1.11 (range = 1.09-1.14).

An estimated 427 people took part in the 2004 fishing derby. It was estimated, by extrapolation of the creel census data from 66 interviewed anglers (Table 4), that the harvest of Arctic char over the two days of fishing was approximately 472-474 fish (954-958 kg). These numbers do not include any char caught and retained from outside official fishing derby hours. A total of 673 angling hours was expended by the registered anglers during the derby.

The fishing derby was still popular with residents of Qikiqtarjuaq as evidenced by the similar numbers of participants in both years of the survey (2002 = 425; 2004 = 427). Fishing pressure declined from 2002 (1276 angling hours) to 2004 (673 angling hours). However, this may be partly explained by the fact that three days of fishing took place in 2002 while only two days were officially fished in 2004. Angling success was better in 2004 (0.70 char per angler hour) than 2002 (0.40 char per angler hour) although fewer char were removed from the lake in 2004 (472-474) than in 2002 (510-515). However, total weight of char removed in 2004 (954-958 kg) was greater than that in 2002 (822-830 kg) (i.e., the char captured and measured were larger in 2004).

A review of the literature found no references to reports of creel census information collected from Arctic char captured by sport fishing through the ice in over-wintering areas. Therefore, the results from the Qikiqtarjuaq fishing derby could only be compared with results from select creel censuses of open-water sport fisheries for char in Nunavut. Moshenko (1981) reported that 95% of the anglers on the Robertson River, in the Pond Inlet (Mittimatalik) area, were successful in catching at least one char and the catch per unit effort was 1.2 char per angler hour. Kristofferson and Sopuck (1983) reported success rates of 26% for the 1976 and 47% for the 1977 char sport fisheries on the Sylvia Grinnell River (Iqaluit area). Their catch rates were 0.3 and 0.4 char per angler hour, respectively for those years. Carder (1991) reporting on the sport fishery on Freshwater Creek, near Cambridge Bay (Iqaluktuuttiaq), for 1982, 1983 and 1984 calculated catch rates of 0.37, 0.37 and 0.21, respectively. Creel censuses were also conducted on the Diana River, in the Rankin Inlet (Kangiqliniq) area in 1984, 1985 and 1986 (Carder 1992). Catch rates for the Diana River angling fishery were reported in two categories: subsistence (local) anglers and tourist (non-local) anglers. The local anglers were more successful in all three years of the study with 0.95 (1984), 1.71 (1985) and 0.62 (1986) char per angler-hour compared to 0.48, 1.02 and 0.49 char per angler hour for the non-residents. Qikiqtarjuaq fishing derby success rates (100% and 89%, respectively) and catch rates (0.40 and 0.70 char per angler hour, respectively) compare favourably to other char sport fisheries.

BIOLOGICAL EVALUATION

Similar to the creel census information, a literature review found no references to biological information collected from Arctic char captured by sport fishing through the ice. Thus, the results from the Nalusiaq Lake fishing derby were compared with results from studies of open-water sport fisheries for char in Nunavut. Biological data for individual fish captured and sampled in 2002 and 2004 are presented in Appendices 2 and 3, respectively.

Size composition of the catch

A total of 100 Arctic char from Nalusiaq Lake were measured and weighed during the 2002 fishing derby. Length frequency distributions for these fish (all fish including females, males and fish where sex was not determined and by sex) are shown in Fig. 4 (also see Appendix 4). The all fish sample of char ranged in fork length from 193-761 mm with a mean length of 521 mm (Fig. 4a). Char identified as females had a fork length range of 367-650 mm (mean = 518 mm)

(Fig. 4b) while males ranged in length from 363-761 mm and had a mean of 541 mm (Fig. 4c). The sex of several small fish (<300 mm in length) was unable to be determined (Fig. 4a). The sampled catch of all fish appeared to be slightly bimodal (i.e., two relatively strong length groups) (Fig. 4a). The first group or mode was composed of fish in the 400-450 mm length range. This group contained mainly males (see Fig. 4a, c). The second mode of 500-550 mm fish was made up mainly of females (see Fig. 4a, b). Female char showed a uni- or single-modal length frequency distribution (Fig. 4b) while the males showed a bimodal distribution (Fig. 4c). The all sex catch (total catch) ranged in weight from 60-4320 g (mean = 1661 g). Female char ranged in weight from 490-3780 g (mean = 1549 g) while males ranged from 490-4320 g (mean = 1790 g) (see Appendix 4).

A total of 108 Arctic char from Nalusiaq Lake were measured and weighed during the 2004 fishing derby (including 24 that were gillnetted). Length frequency distributions for these fish (all fish and by sex) are shown in Fig. 5 (also see Appendix 5). The all fish sample of char ranged in fork length from 215 - 757 mm with a mean length of 546 mm (Fig. 5a). Char identified as females had a fork length range of 294 - 673 mm (mean = 541 mm) (Fig. 5b) while males ranged in length from 215 - 757 mm and had a mean of 570 mm (Fig. 5c). The sampled catch of all fish appeared to be slightly bimodal. The first group or mode was composed of fish in the 400-450 mm length range. The second mode of 550-600 mm fish was made up mainly of females (see Fig. 5a, b). Female char showed a unimodal length frequency distribution (Fig. 5b) while the males showed a bimodal distribution (Fig. 5c). Length frequency distributions for angled and gillnetted char are also shown (Appendices 6 and 7, respectively). The all fish catch ranged in weight from 100-4450 g (mean = 1069 g). Female char ranged in weight from 200-3500 g (mean = 1826 g) while males ranged from 100-4450 g (mean = 2371 g) (see Appendix 5).

The length frequency distributions for the overall catches for both years of the fishing derby showed a slight bimodal tendency (Figs. 4a, 5a). This overall bimodality appeared to be the result of the bimodality noted in the males (Figs. 4c, 5c) as the females caught in both years showed unimodal length frequency distributions (Figs. 4b, 5b). There was a slight shift to larger fish being caught in 2004 as indicated by the second mode in Figs. 4a and 5a.

Length ranges from the studies cited below are approximate as they were taken from length frequency figures and/or tables in the resultant reports (length data for individual fish were not available). Moshenko (1981), in a study of the Arctic char sport fishery on the Robertson River, reported a fork length range (all fish) of 400-850 mm (mean = 659 mm). Robertson River

females had a length range of 400-800 mm (mean = 621 mm) while males ranged in length from 550-850 mm and had a mean of 720 mm. The Robertson River char had a unimodal length frequency distribution with the single modal group between 600-700 mm in length. In a study on the stressed (i.e., heavily fished) Sylvia Grinnell River char stock, Kristofferson and Sopuck (1983) reported a length range (all fish) of 100-600 mm (mean = 338 mm). Similar to the Robertson River catch, the Sylvia Grinnell catch was unimodal in distribution although its modal group was much smaller (300-350 mm). Sylvia Grinnell River females (range = 100-500 mm, mean = 334 mm) were smaller than males (range = 200-600 mm, mean = 346 mm). In another study, Carder (1992) sampled the char in the 1984 sport fishery on the Diana River. Char from this fishery had a length range (all fish) of 250-800 mm (mean = 470 mm). Diana River females had a fork length range of 350-650 mm (mean = 487 mm) while males ranged in length from 300 to 650 mm and had a mean length of 482 mm. Similar to the Robertson and Sylvia Grinnell rivers, Diana River char had a uni-modal length frequency distribution (modal group = 450-500 mm). Although, unlike for those stocks listed above, there is a bimodal shape to the length frequency distribution for Nalusiaq Lake char, this is not unusual as Johnson (1983) stated that both unimodal and bimodal length frequency distributions are common in Arctic char stocks. For example, Carder (1991), while conducting a creel census at Freshwater Creek, recorded some biological data on the char catch. He reported a length range (all fish) of 250-850 mm (mean = 582 mm). Freshwater Creek females had a fork length range of 250-800 mm (mean = 545 mm) while males ranged in length from 250-850 mm and had a mean length of 612 mm. Similar to the Nalusiaq Lake char, the all fish and males only sample of Freshwater Creek char had bimodal length frequency distributions with a strongly represented group in the 450-500 mm range and another in the 650-750 mm range. Freshwater Creek female char also showed a unimodal length frequency distribution.

Age composition of the catch

Age frequency distributions for Arctic char angled from Nalusiaq Lake during the 2002 fishing derby (all fish and by sex) are shown in Fig. 6 (also see Appendix 8). Fish (all sexes) caught and sampled during the derby ranged in age from 6 to 21 years (Fig. 6a). The sampled catch is unimodal with a modal age of 12 years and a mean age of 12.6 years. Females had a narrower age range (9-17 years, Fig. 6b) than males (7-21 years, Fig. 6c). Mean age for females was 12.7 years and 13.0 years for males. The strongest (modal) age group for both sexes was the 12-year-old group although 13 year olds were also quite abundant in the female component.

Age frequency distributions for Arctic char caught (angled and gillnetted combined) from Nalusiaq Lake during the 2004 fishing derby (all fish and by sex) are shown in Fig. 7 (also see Appendix 9). Fish (all sexes) caught and sampled during the derby ranged in age from 5-24 years (Fig. 7a). The sampled all fish catch was bimodal with one mode at 9 years and another at 14 years. Mean age was 14.3 years. Females had a narrower age range (9-20 years, Fig. 7b) than males (5-24 years, Fig. 7c). Mean age for females was 14.7 years while for males, it was 14.1 years. The strongest (modal) age group for both sexes was the 14-year-old group although 13 year olds were equally represented in the female component. Age frequency distributions for angled and gillnetted char are also shown (Appendices 10 and 11, respectively).

There is a tendency for Arctic char age frequency distribution curves to be of similar shape to length frequency distribution curves (Johnson 1983). This appeared to be the case with Nalusiaq Lake char where the unimodal 2002 age frequency distribution (Fig. 6) was similar to the only slightly bimodal length frequency distribution (Fig. 4, one more specimen in the 450-500 mm group or one less in the 400-450 group and it would have been unimodal). The 2004 age frequency distribution showed a bimodality (Fig. 7) which corresponded the bimodality of the length frequency data (Fig. 5).

A very strong year-class is evident in the Nalusiaq Lake char population: the 1990 year-class of fish (i.e., fish born in that year) (12+ years old in 2002, Fig. 6; 14+ years old in 2004, Fig. 7). Another potentially strong year-class has also started having an effect on the population. This is the 1995 year-class (7+ years old in 2002, Fig. 6; 9+ years old in 2004, Fig. 7).

For our study of Nalusiaq Lake char, the "break-and-burn" (section) method of determining ages was used whereas, in the studies referred to below, ages were determined by using the whole otolith method. The whole otolith method has a tendency to underestimate ages of mature char (i.e., older fish) (Barber and McFarlane 1987; Kristoffersen and Klemetsen 1991; J. Babaluk and R. Wastle, unpubl. data).

Arctic char (all sexes) caught and sampled during the 1979 Robertson River sport fishery ranged in age from 11 to 28 years (Moshenko 1981). The sampled catch appeared to be unimodal with a modal age of 18 years and a mean age of 17.9 years. Males ranged in age from 14-28 years while females ranged from 11-24 years. Mean age for males was 19.2 years while for females it was 17.2 years. The strongest (modal) age group for both sexes was the 18-year-old group. Arctic char (all sexes) caught and sampled during the 1977 Sylvia Grinnell River sport fishery

ranged in age from 5-16 years (Kristofferson and Sopuck 1983). The sampled catch also appeared to be unimodal with a modal age of 11 years and a mean age of 10.5 years. Males ranged in age from 5-16 years while females ranged from 6-15 years. The strongest (modal) age groups for both sexes were the 10-11 year olds. Arctic char (all sexes) caught and sampled during the 1983 Freshwater Creek sport fishery ranged in age from 6 to 19 years (Carder 1991). The sampled catch also appeared to be unimodal with a modal age of 12 years and a mean age of 11.8 years. Males and females ranged in age from 6-19 years. The strongest (modal) age group for both sexes was the 12-year-old group. Arctic char (all sexes) caught and sampled during the 1984 Diana River sport fishery ranged in age from 6-13 years (Carder 1992). The sampled catch also appeared to be unimodal with a modal age of 8 years and a mean age of 8.4 years. Males and females ranged in age from 6-13 years. The strongest (modal) age group for both sexes was the 8-year-old group.

Growth

The relationships between fork length and age (i.e., growth rate) for Nalusiaq Lake Arctic char, based on the sampled catches from this study, are shown in Figs. 8 (2002) and 9 (2004). There appeared to be no differences in overall growth rates between 2002 and 2004 (Figs. 8a and 9a). There also appeared to be no difference in growth rates between females and males (Figs. 8b, c and 9b, c). It appeared that male char in Nalusiaq Lake live slightly longer and reach greater ultimate lengths than females (Figs. 8b, c and 9b, c). Although the 2002 sample indicated that only one growth form (likely anadromous life history) was present in the lake (Fig. 8), the 2004 sample suggested that two growth forms were present (Fig. 9). Two specimens (one 13 years, ~340 mm and the other 24 years, ~220 mm) were likely non-anadromous (slower growing, lake residents) while the remainder were likely faster-growing anadromous fish (see otolith microchemistry section below).

The 10-year-old char (n = 10) that were sampled from the 2002 and 2004 fishing derbies had a mean length of 406 mm (range = 359-497 mm) while the 15-year-old fish (n = 10) sampled from both years had a mean length of 604 mm (range = 511-680 mm). For comparison, 10-15 year-old fish from the Sylvia Grinnell River had mean lengths of 340 mm and 438 mm (Kristofferson and Sopuck 1983), respectively while Freshwater Creek 10 and 15 year old fish had mean lengths of 498 mm and 697 mm (Carder 1991). In the Robertson River catch, no 10-year-old fish were present but 15-year-old fish had a mean length of 557 mm (Moshenko 1981) while in the Diana River creel census sample, 10-year-old char had a mean length of 549 mm and no 15-

year-olds were caught.

The relationship between body weight (W) and fork length (L) for Arctic char (all fish) caught in 2002 from Nalusiaq Lake is graphically presented in Fig. 10a and is described by the equation:

$$\text{Log}_{10}\, W = -5.298 + 3.115\, (\log_{10} L)$$

($r^2 = 0.972$, n = 100).

Mean relative condition factor (K) for the 2002 Nalusiaq Lake Arctic char all fish catch was 1.03 (n = 100, see Appendix 4).

For 2004, the weight-length relationship for Nalusiaq Lake Arctic char (all fish) is graphically presented in Fig. 11a and is described by the equation:

$$\text{Log}_{10}\, W = -5.708 + 3.271\, (\log_{10} L)$$

($r^2 = 0.986$, n = 106).

Mean relative condition factor (K) for the 2004 Nalusiaq Lake Arctic char all fish catch was 1.08 (n = 108, see Appendix 5).

The relationship between fork length (L) and body weight (W) for 2002 Arctic char females from Nalusiaq Lake is graphically presented in Fig. 10b and is described by the equation:

$$\text{Log}_{10}\, W = -5.280 + 3.112\, (\log_{10} L)$$

($r^2 = 0.931$, n = 55).

Mean relative condition factor (K) for 2002 Nalusiaq Lake female Arctic char was 1.06 (n = 55, see Appendix 4).

For 2004, the relationship between fork length (L) and body weight (W) for Arctic char females from Nalusiaq Lake is graphically presented in Fig. 11b and is described by the equation:

$$Log_{10} W = -6.079 + 3.403 (log_{10} L)$$

$$(r^2 = 0.970, n = 27).$$

Mean relative condition factor (K) for 2004 Nalusiaq Lake female Arctic char was 1.05 (n = 28, see Appendix 5).

The relationship between fork length (L) and body weight (W) for 2002 Arctic char males from Nalusiaq Lake is graphically presented in Fig. 10c and is described by the equation:

$$Log_{10} W = -5.193 + 3.071 (log_{10} L)$$

$$(r^2 = 0.973, n = 42).$$

Mean relative condition factor (K) for 2002 Nalusiaq Lake male Arctic char was 1.01 (n = 42, see Appendix 4).

For 2004, the relationship between fork length (L) and body weight (W) for Arctic char males from Nalusiaq Lake is graphically presented in Fig. 11c and is described by the equation:

$$Log_{10} W = -5.652 + 3.252 (log_{10} L)$$

$$(r^2 = 0.991, n = 39).$$

Mean relative condition factor (K) for 2004 Nalusiaq Lake male Arctic char was 1.10 (n = 40, see Appendix 5).

Kristofferson and Sopuck (1983) gave the following weight-length relationship equations for Sylvia Grinnell River Arctic char and Robertson River (all fish), respectively: $Log_{10} W = -5.2101 + 3.0724 (log_{10} L)$ and $Log_{10} W = -4.9933 + 3.0041 (log_{10} L)$. Moshenko (1981) calculated condition factors (K) of 1.01 (males), 0.96 (females) and 1.01 (all fish) for Robertson River char returning from the sea in fall 1979 while Carder (1991) gave condition factors of 0.97 (males), 0.96 (females) and 0.96 (all fish) for Diana River char migrating to the sea in spring 1984. Weight-length relationships and condition factors can be variable within and between years (e.g., a char returning from the sea will be "fatter" than one about to migrate to the sea after spending

a winter in fresh water).

Gill rakers

Gill rakers are the bony, finger-like projections of the gill arch on the opposite side from the red-coloured gill filaments (Fig. 2). The gill rakers point forward and inward and function in retaining prey. They vary in number between species and can vary in number within a species. Fish which eat larger prey usually have fewer gill rakers than fish that feed on small food items (e.g., plankton). Gill rakers can be a useful tool for identifying fish. With counts that encompass the range as described by Scott and Crossman (1973), there appeared to be greater variability in Nalusiaq Lake Arctic char gill raker counts (upper = 8-14, lower = 12-19) than that of other anadromous and non-anadromous populations on Baffin Island (e.g., Nettilling Lake, Sapuladjuk) (Table 5). This suggested that Nalusiaq Lake char feed on a wider range of food items (e.g., plankton, benthos, fish) than other char populations.

OTOLITH MICROCHEMISTRY

Otoliths ("ear stones") are small, paired structures found in a fish's inner ear that are used to sense orientation and acceleration (Fig. 2). They are composed mainly of a calcium carbonate (aragonite) and protein matrix but trace elements similar to calcium (Ca), such as strontium (Sr), can be incorporated into or replace Ca in the otolith (Degens et al. 1969). The Ca and trace elements are derived mainly from the waters that the fish inhabits (Ichii and Mugiya 1983). Otoliths do not undergo resorption during the life of the fish (Campana and Neilson 1985) and thus provide an elemental record of the fish's life. Sea water contains, on average, 8.0 $mg \cdot L^{-1}$ (ppm) Sr whereas fresh water contains, on average, 0.1 $mg \cdot L^{-1}$ Sr (Rosenthal et al. 1970). For example, in Quttinirpaaq National Park lakes (northern Ellesmere Island), Sr concentrations range from 0.033-0.329 $mg \cdot L^{-1}$ (Babaluk et al. 1999). Kalish (1989) showed that these differences in Sr levels between sea water and fresh water were evident in fish otolith composition and thus could be used to retrospectively determine life history characteristics (e.g., anadromous behaviour) in fish and Sr concentrations in otoliths closely reflect levels in the waters that the fish live (Babaluk et al. 1998).

Arctic char of known life histories

Figure 12a shows a typical Sr distribution profile from an otolith of a known non-anadromous

Arctic char from Kilbourne Lake (no outlet to the sea) in Quttinirpaaq National Park, Nunavut. This pattern shows a relatively constant and low Sr content ("flat" profile) from the core area (0 microns) to the outer edge of the otolith (~1400 microns) indicating that this fish occupied an environment in which the Sr content was relatively low and relatively constant (i.e., the fresh water of Kilbourne Lake) throughout its life.

Figure 12b shows a typical Sr distribution profile from an otolith of a known anadromous Arctic char (the fish was caught while migrating from the sea to fresh water) from Halovik River on Victoria Island, Nunavut. The pattern has a low Sr region corresponding to the core area and the first several years of the fish's life which were passed entirely in fresh water. This is followed by a marked increase in Sr content corresponding to when the fish first migrated to a high Sr environment (i.e., the sea). The elevated Sr content seen in the subsequent oscillatory peaks is easily distinguishable from the lower levels typical of the freshwater stage of its life history. The observed Sr peaks are consistent with annual summer feeding trips to the sea followed by a return to fresh water in the fall to over-winter.

The Sr distribution profiles illustrated in Fig. 12 were determined by scanning proton microprobe analysis. Although we used electron microprobe analysis on the Nalusiaq Lake char otoliths, the Sr profiles derived by this instrument would be similar to ones derived by the proton microprobe (Campana et al. 1997; R. Brown, U.S. Fish and Wildlife Service, Fairbanks, AK, USA, personal communication).

Nalusiaq Lake Arctic char of unknown life histories

All 10 Nalusiaq Lake Arctic char otolith Sr distributions showed a pattern of low Sr levels that lasted for several years followed by a pattern of relatively high, usually annually fluctuating Sr levels that continued until the fish were captured (Figs. 13-22). Based on comparison with the Sr distribution profiles for known non-anadromous and anadromous Arctic char (Fig. 12), all of the Nalusiaq Lake char otoliths analyzed were from anadromous individuals (i.e., the Sr profiles resemble that of the known Arctic char).

Figure 13 shows the otolith Sr distribution from a Nalusiaq Lake Arctic char (designated as no. 49013). The life history of this fish as interpreted from the Sr distribution pattern is as follows. The age of this fish at time of capture was 9+ years (i.e., entering its 10^{th} year of life). The pattern of Sr distribution for this char has a region of relatively low Sr levels which correspond to the first

several annuli. A marked increase in Sr content corresponds to the region of the 4th annulus, indicating that in its 5th year, this fish moved to an environment with a higher Sr content (i.e., the sea). This fish made five annual migrations to and from the sea before being captured during the fishing derby in May 2002 in fresh water. Although there are some "minor" Sr peaks prior to the fish's first seaward migration, in particular in the fish's first year (~1500 ppm), they are of a level that meets the fresh water residence criteria set out above (Materials and Methods section). A possible explanation for these variable levels is that uptake of Sr into the otoliths may be related to body growth rate (i.e., greater growth, thus higher Sr, in summer than in winter (Sadovy and Severin 1994).

Figure 14 shows the Sr distribution from an otolith from Arctic char no. 48964. The age of this fish at time of capture was determined as 8+ years (i.e., entering its 9th year of life). The pattern of Sr distribution for this char has a region of relatively low Sr levels which correspond to the first several annuli. A marked increase in Sr content corresponds to the region of the 4th annulus, indicating that in its 5th year, this fish migrated to the sea. This fish made four annual migrations to and from the sea before being captured in May, 2002 in fresh water (8th annulus).

Figure 15 shows the otolith Sr distribution from Arctic char no. 48966 that was captured in May, 2002 at age 17+ years. This char first migrated to sea during its 7th year (6+ years old) and, although there are large variations in the subsequent Sr peaks, it appears to have made 11 consecutive annual excursions into waters with higher Sr levels. Although several of the Sr peaks are at ~1500 ppm, it was assumed that these represented migrations into a marine environment (estuary or ocean).

The Sr distribution for Arctic char no. 48970, depicted in Fig. 16, suggested that it first migrated to sea during its 4th year (3+ years old) and appeared to have made four consecutive annual excursions to and from the sea before being captured as a 7+-year-old .

Figure 17 shows the otolith Sr distribution from Arctic char no. 48981 that has been interpreted to have migrated to the sea for the first time in its 6th year (5+ years old). This fish made two annual migrations to and from the sea before making what appears to be two migrations within a single year (between the 7th and 8th annuli). This is highly unlikely as there are no published records of this phenomenon. The low Sr levels between the peaks in that year may be the result of deposition of vaterite in the otolith. Vaterite can replace calcite in otoliths and contains very low levels of Sr (Brown and Severin 1999). The fish continued with annual migrations until it was

captured (15+ years).

Figure 18 shows the otolith Sr distribution from a 21+-year-old anadromous Arctic char no. 48982 that migrated to the sea for the first time in its 7th year (6+ years old) and then made 10 consecutive, annual excursions into marine waters. However, in its 17th year (16+ years old), it appears to have remained in fresh water. It migrated again to the sea in its 18th year but then spent two years (19th and 20th) exclusively in fresh water. This behaviour is similar to that of anadromous Arctic char from Nauyuk Lake (Kent Peninsula), Nunavut and has been associated with spawning events (Johnson 1989). In its last year, this fish again migrated to and from the sea before being captured.

Figure 19 shows the otolith Sr distribution from Arctic char no. 48989 that was interpreted as having migrated to the sea for the first time in its 5th year (4+ years old). Similar to the chars depicted in Figs. 13, 16 and 17, there were some "minor" Sr peaks prior to this that have been attributed to variations in annual growth rate. This fish made five annual migrations to and from the sea. Unfortunately, due to an instrument malfunction, the electron beam did not traverse all of the annuli and as a result Sr data for the last three years of the fish's life (annuli 10-12) was not collected.

The previous otoliths (Figs. 13-19) were analyzed along the long axis from the core to the dorsal surface (see Fig. 3b) but because all annuli were not evident along this axis for the remaining three individuals (Figs. 20-22), their otoliths were analyzed along the shorter axis that runs parallel to the sulcus from the core to the edge (see Fig. 3b). Although the annuli along this axis are generally thinner, all are present. As this transect is shorter, fewer sample points are made with a resultant "coarser" (less precise) Sr distribution profile.

Figure 20 shows the otolith Sr distribution from Arctic char no. 48979 that could be interpreted as having migrated to the sea for the first time in its 6th year (5+ years old) although a case could be made for it having migrated to sea for the first time in its 4th year (3+ years old). If it did migrate to sea in its 4th year, it appeared to have remained in fresh water for its 5th year. If it migrated for the first time in its 6th year, this fish made three consecutive annual excursions into waters of higher Sr levels (estuary or ocean); then it remained in fresh water for its 9th year (8+ years); and finally resumed a pattern of three annual sea migrations before it was captured in fresh water during the 2002 fishing derby.

Figure 21 shows the otolith Sr distribution from a 21+-year-old Arctic char no. 48996 that migrated to the sea for the first time in its 5th year (4+ years old) and then made eight consecutive annual excursions into waters of higher strontium levels. It remained in fresh water for its 13th year (12+ years) and then resumed a pattern of five annual sea migrations. In its 18th year, it again remained in fresh water followed by another year with a migration (19th year) and then no migration in its 20th year. It migrated one more time (21st year) before it was captured in fresh water during the 2002 fishing derby. The high levels of Sr at the otolith core are greater than subsequent levels in the fish's freshwater phase. These levels may be the result of the waters of the fish's natal (spawning) area having a much higher level of Sr than other parts of the Nalusiaq Lake system or, more likely, they could be the result of this specimen being the progeny of a female char that returned from the sea the same year that it spawned (i.e., eggs would be developing while the fish was at sea). The composition of the developing egg would reflect the chemical composition of the seawater environment (i.e., higher Sr). Since the progeny's otolith begins formation in the embryonic stage, a higher level of strontium would be evident in the otolith (Kalish 1990).

Figure 22 shows the otolith Sr distribution from a 15+-year-old Arctic char no. 49036 that migrated to the sea for the first time in its 7th year (6+ years old) and then made eight consecutive annual excursions into waters of higher strontium levels. In the year prior to capture, it appears to have remained in fresh water.

Otolith Sr distributions can be a very useful tool to retrospectively determine life history characteristics of fish populations although the interpretation of the data can in some cases by subjective and very speculative (e.g., Fig. 20). The Arctic char of Nalusiaq Lake have a varied and complex set of life history traits. From our limited otolith Sr distribution data, it appeared that age-at-first migration to the sea can range from 3+ years old (4th year of life) to 6+ (7th year). Once seaward migrations begin, they can continue uninterrupted on an annual basis (e.g., Fig. 13) or they can be interrupted by periods of a year or more spent in fresh water, perhaps for spawning events. Relatively low Sr levels in the otolith core (i.e., 0-20 sample points) for the majority of Nalusiaq Lake char analyzed suggested that these char (females) spend the year leading up to spawning in fresh water. However, the relatively high level of Sr in the core of one specimen (Fig. 21) suggested that some females may spawn in years that they also migrated to and from the sea.

GENETICS

A summary of the genetic data for Nalusiaq Lake Arctic char is presented in Table 6. Mitochondrial DNA sequencing can be used to indicate whether Nalusiaq char are closely related to previously described groups of char (e.g., Greenland Arctic char, central Canadian Arctic char) while microsatellite analysis can assess differences within the Nalusiaq Lake stock and between it and geographically, closely related stocks (e.g., other stocks on Baffin Island). Further analysis of these data will be conducted in the future.

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Table 1. Ranges of otolith Sr concentrations for select anadromous, freshwater and marine fish species.

Species	Location	Otolith Sr range (ppm)		Source
		Freshwater	Marine (includes estuary)	
Arctic char (*Salvelinus alpinus*)	Selected Canadian central and western Arctic	<600	1500-3000	J. Babaluk (unpubl. data)
Dolly Varden (*Salvelinus malma*)	North Slope (Alaska)	400-1000	1500-3000	J. Babaluk (unpubl. data)
Arctic char/Dolly Varden	Kodiak Island (Alaska)	700-1500	1500-2200	J. Babaluk (unpubl. data)
Inconnu (*Stenodus leucichthys*)	Mackenzie River	~ 1000	1500-3700	Howland et al. (2001)
Sockeye salmon (*Oncorhynchus nerka*)	Beaufort Sea	400-600	1800-3300	Babaluk et al. (2000)
Kokanee (*Oncorhynchus nerka*)	Great Slave Lake	400-750	na	Babaluk et al. (2000)
Striped bass (*Morone saxatilis*)	Hudson River/Long Island Sound (New York)	600-800	2000-2400	Secor et al. (2001)
Striped bass	Roanoke River/Albemarle Sound (North Carolina)	0-2000	2000-8000	Morris et al. (2005)
Greenland halibut (*Reinhardtius hippoglossoides*)	Davis Strait	na	1500-3000	J. Babaluk (unpubl. data)

Table 2. Microsatellite primers used in this study. Primer sequences, annealing temperatures and references are shown. Primers that were fluorescently labelled have been denoted with an *. The number in brackets under the microsatellite locus name indicates the PCR program profile that was used.

Locus	Primer sequence (5' → 3') F- forward, R-reverse	Annealing temp (°C)	Reference
Mst85 (1)	F: GGAAGGAAGGGAGAAAGGT*	50	Presa and Guyomard (1996)
	R: GGAAAATCAATACTAACAA		
Sal5 (2)	F: TTTGCATTGAGCCTCTGTTG*	48/53	R.G. Danzmann (University of Guelph, Guelph, ON, personal communication)
	R: TGTTTCAGCTGCTATTAGGAAAT		
Sal38 (1)	F: CGCCTTGTCATACATTACACC*	50	McGowan et al. (2004)
	R: ACGCTACAGAAACAGGAGAAAG		
Sal39 (2)	F: GGGGAGTCTGTGTTAAGTTGG*	48/53	McGowan et al. (2004)
	R: TGAATGGACGTTCCTCTGAC		
Sal81 (2)	F: CAGCATAATCACTCCCGC*	48/53	McGowan et al. (2004)
	R: GAAAGCTACCTTGCGTGC		
Sa72Zim (2)	F: AACTTCAAGATATATGATGT*	45/53	Englbrecht et al. (2000)
	R: ATTCGTTTAGTCTGAGAA		
Sco19 (1)	F: CTTGAAATTAGTTAAACAGC*	50	Taylor et al. (2001)
	R: CCAAACTACCCAATAATC		
Sfo8 (1)	F: CAACGAGCACAGAACAGG*	55	Angers et al. (1995)
	R: CTTCCCCTGGAGAGGAAA		
Sfo23 (1)	F: GTGTTCTTTTCTCAGCCC	55	Angers et al. (1995)
	R: AATGAGCGTTACGAGAGG*		
Ssa85 (2)	F: AGGTGGGTCCTCCAAGCTAC	48/53	O'Reilley et al. (1996)
	R: GTTTCTTACCCGCTCCTCACTTAATC*		
Ssa422 (1)	F: TTATGGGCGTCCACCTCT	55	Cairney et al. (2000)
	R: CACCCCAGCCTCCTCAACCTTC*		

Table 3. Summary of creel census information from the Qikiqtarjuaq fishing derby at Nalusiaq Lake, May 2002.

Date	Number of angler interviews	Number of Arctic char caught	Hours fished	Number of Arctic char per angler interview	Number of Arctic char per angler hour
May 25	66	84	267.69	1.27	0.31
May 26	12	15	11.57	1.25	1.30
May 27	22	22	20.87	1.00	1.05
Total[a] or mean[b]	100[a]	121[a]	300.13[a]	1.21[b]	0.40[b]

Table 4. Summary of creel census information from the Qikiqtarjuaq fishing derby at Nalusiaq Lake, May 2004.

Date	Number of angler interviews	Number of Arctic char caught	Hours fished	Number of Arctic char per angler interview	Number of Arctic char per angler hour
May 22	45	49	61.87	1.09	0.79
May 24	21	24	42.22	1.14	0.57
Total[a] or mean[b]	66[a]	73[a]	104.09[a]	1.11[b]	0.70[b]

Table 5. Comparison of gill raker counts from several Arctic char populations in the Canadian Arctic.

Location	Form or life history type	Upper arch		Lower arch		Source
		Range	Mean	Range	Mean	
Nalusiaq Lake (Auyuittuq National Park)	Unknown	8-14	10.6	12-19	15.5	This study
Nettilling Lake (Baffin Island)	Anadromous	-	-	14-17	16	McPhail (1961)
Sapuladjuk (Cape Dorset area, Baffin Island)	Non-anadromous	-	-	14-17	16	McPhail (1961)
Cambridge Bay area (Victoria Island)	Anadromous	-	10.9	-	15.5	Reist et al. (1997)
Lakes 103/104 (Ivvavik National Park)	Non-anadromous	-	10.3	-	17.0	Reist et al. (1997)
Lake Hazen (Quttinirpaaq National Park)	Non-anadromous, large	-	10.2	-	15.5	Reist et al. (1997)
Lake Hazen (Quttinirpaaq National Park)	Non-anadromous, small	-	10.3	-	15.2	Reist et al. (1997)
Canadian Arctic (in general)	All	7-13	-	12-19	-	Scott and Crossman (1973)

Table 6. Genetic data at 11 microsatellite loci and the sequence haplotypes for the mitochondrial DNA (mtDNA) control region's left and right domains. Identification of the alleles for the microsatellite data is given in base pairs. "xxx" indicates no data. Mitochondrial haplotypes have been assigned based on the variation seen in the sequence alignments of all samples analyzed.

Sample ID	Microsatellite																						mtDNA haplotype	
	Sal81		Mst85		Sal5		Sal38		Sal39		Sa72Zim		Sco19		Sfo8		Sfo23		Ssa85		Ssa422		left domain	right domain
48964	144	146	212	212	202	242	153	193	xxx	xxx	148	158	201	245	281	283	185	217	206	238	249	249	e1A	Sal01
48965	144	144	206	214	202	246	151	175	xxx	xxx	148	152	201	245	257	277	217	219	206	214	249	253	e1A	Sal03
48966	144	144	212	214	232	232	151	151	xxx	xxx	148	148	199	249	259	291	207	215	218	238	219	225	e1A	Sal01
48967	144	144	214	214	202	242	117	153	228	240	148	152	199	249	277	279	205	219	206	214	215	249	e1A	Sal01
48968	144	144	212	214	210	252	149	151	240	260	148	148	249	253	xxx	xxx	207	211	214	238	249	253	e1A	Sal04
48969	144	146	212	212	202	242	153	225	228	248	148	198	199	199	281	281	185	195	206	238	249	249	e1A	Sal01
48970	144	144	212	224	202	252	143	153	240	264	148	152	235	237	281	285	335	355	232	240	225	253	e1A	Sal01
48971	144	148	212	214	214	252	151	239	262	262	148	148	249	251	257	263	207	209	214	242	249	249	e1D	Sal01
48972	144	144	212	214	xxx	xxx	151	153	240	260	148	148	249	251	263	281	205	207	214	214	219	249	e1A	Sal01
48973	144	144	212	212	242	242	153	221	xxx	xxx	148	148	247	251	281	291	205	207	214	240	249	249	e1A	Sal04
48974	144	144	214	224	252	254	147	153	240	260	148	198	199	201	261	287	209	217	206	206	249	249	e1A	Sal01
48975	144	144	214	214	200	250	149	243	xxx	xxx	148	148	249	251	261	291	185	195	214	238	225	249	e1A	Sal01
48976	144	144	xxx	xxx	202	214	149	153	228	260	148	152	199	249	279	291	209	291	216	230	249	253	e1A	Sal01
48977	144	144	212	212	202	252	117	149	240	248	152	152	203	203	261	291	197	217	206	212	xxx	xxx	e1A	Sal03
48978	xxx	xxx	xxx	xxx	236	236	161	197	260	260	152	152	259	259	279	311	xxx	xxx	xxx	xxx	215	253	e1A	Sal02
48979	144	144	212	214	202	214	151	153	248	260	198	198	249	249	263	295	209	209	214	238	249	249	e1A	Sal01
48980	144	144	212	214	202	232	155	221	260	262	xxx	xxx	249	253	261	291	203	207	208	214	249	249	e1A	Sal01
48981	144	144	212	224	200	202	135	143	240	260	148	158	249	269	263	291	195	209	214	242	249	249	e1A	Sal01
48982	144	144	xxx	xxx	232	252	119	153	240	270	152	152	199	255	257	263	209	211	206	206	225	225	e1A	Sal01
48983	144	144	212	214	252	252	151	237	260	262	152	184	201	201	257	257	205	219	206	244	225	249	e1A	Sal01
48984	144	144	212	212	230	252	149	197	262	264	148	148	245	251	283	293	335	355	206	238	249	249	e1A	
48985	144	146	210	214	242	242	153	153	xxx	xxx	148	158	203	249	277	291	209	219	218	238	225	249	e1A	
48986	144	144	212	214	202	252	121	199	240	260	xxx	xxx	249	251	291	291	xxx	xxx	238	238	xxx	xxx	e1A	
48987	144	144	212	214	230	242	151	155	xxx	xxx	148	152	235	253	281	295	185	219	216	234	249	249	e1A	
48988	xxx	xxx	212	212	188	254	147	151	240	248	148	148	201	249	xxx	xxx	205	283	xxx	xxx	xxx	xxx	e1A	
48989	144	144	214	214	202	242	153	155	260	260	148	158	251	253	279	279	189	209	206	240	249	249		
48995	xxx	xxx	214	214	202	232	153	155	262	262	148	148	199	249	257	291	207	207	xxx	xxx	249	249		
48996	144	144	214	214	202	232	153	225	260	260	148	152	249	261	261	281	xxx	xxx	210	238	249	249		
48997	144	144	xxx	xxx	202	252	151	151	260	262	148	152	255	255	277	291	205	211	206	206	253	253		
49012	144	144	214	224	xxx	xxx	151	153	240	266	148	152	203	249	261	291	207	219	214	240	249	253		
49013	144	144	212	212	202	254	117	135	xxx	xxx	158	158	199	199	277	285	221	221	206	236	249	251		
49014	144	144	214	216	188	242	149	157	240	264	148	152	241	257	261	281	213	219	240	240	249	249		
49015	126	144	xxx	xxx	188	252	155	177	240	240	152	158	205	205	277	277	207	217	xxx	xxx	219	249		
49035	144	144	214	224	200	210	151	153	xxx	xxx	152	250	xxx	xxx	277	291	193	215	xxx	xxx	249	249		

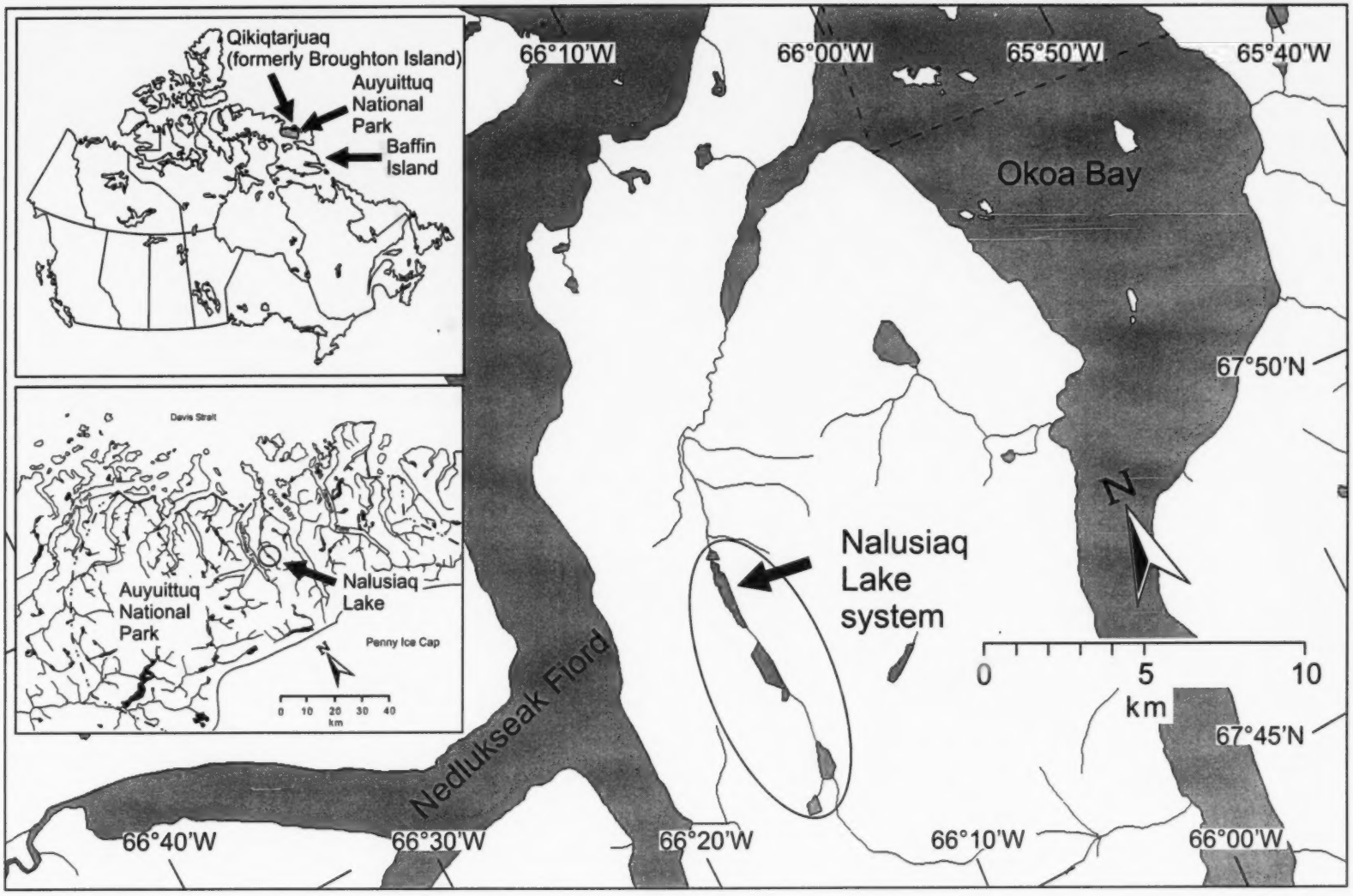


Figure 1. Map of the Nalusiaq Lake area, Auyuittuq National Park, Baffin Island, Nunavut showing the lake where the fishing derby was held (indicated by arrow).

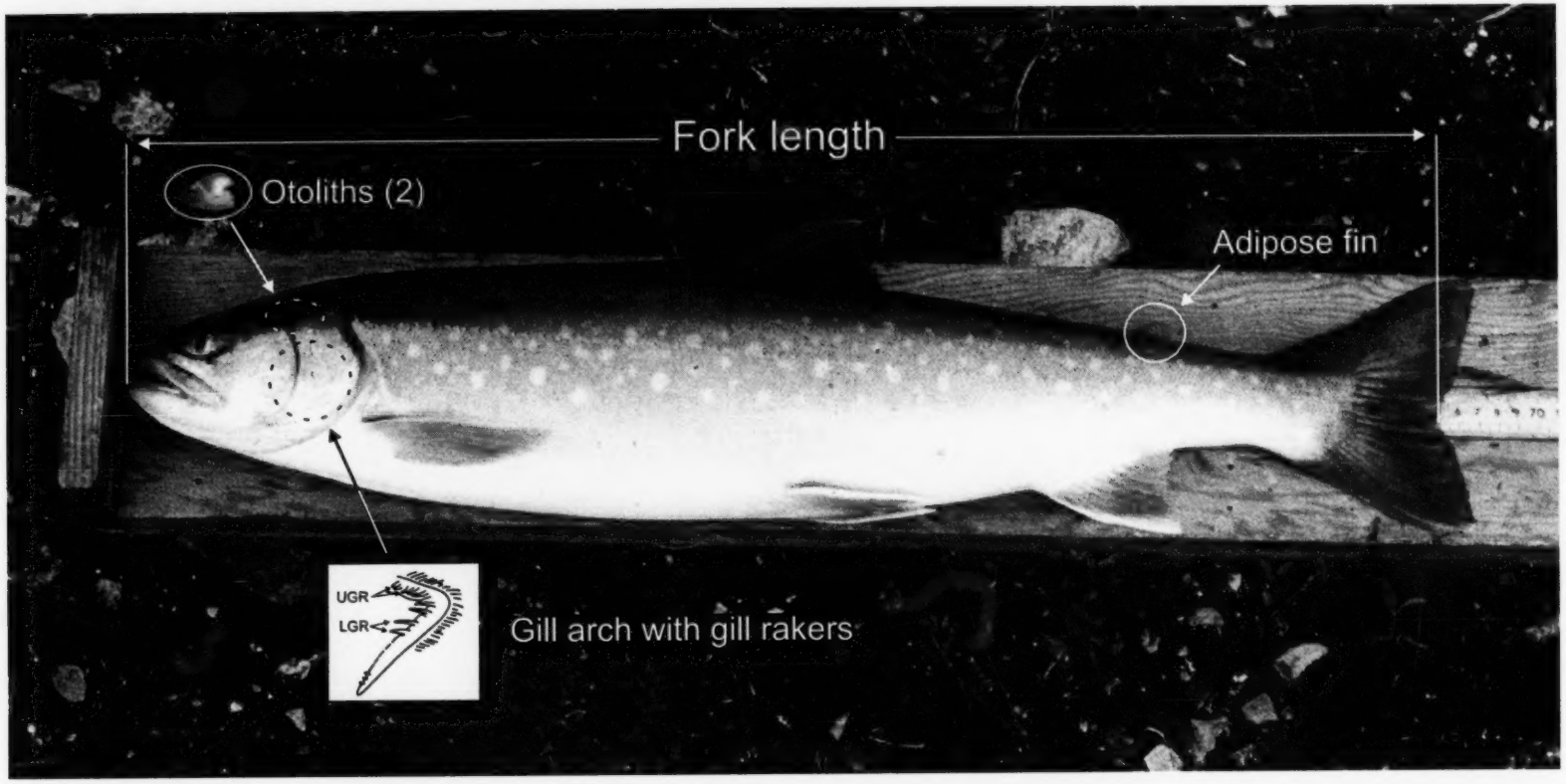


Figure 2. Photograph of an Arctic char showing areas where samples were collected (otoliths, adipose fin, gill arch) and measurement (fork length) was made (UGR = upper gill rakers, LGR = lower gill rakers).

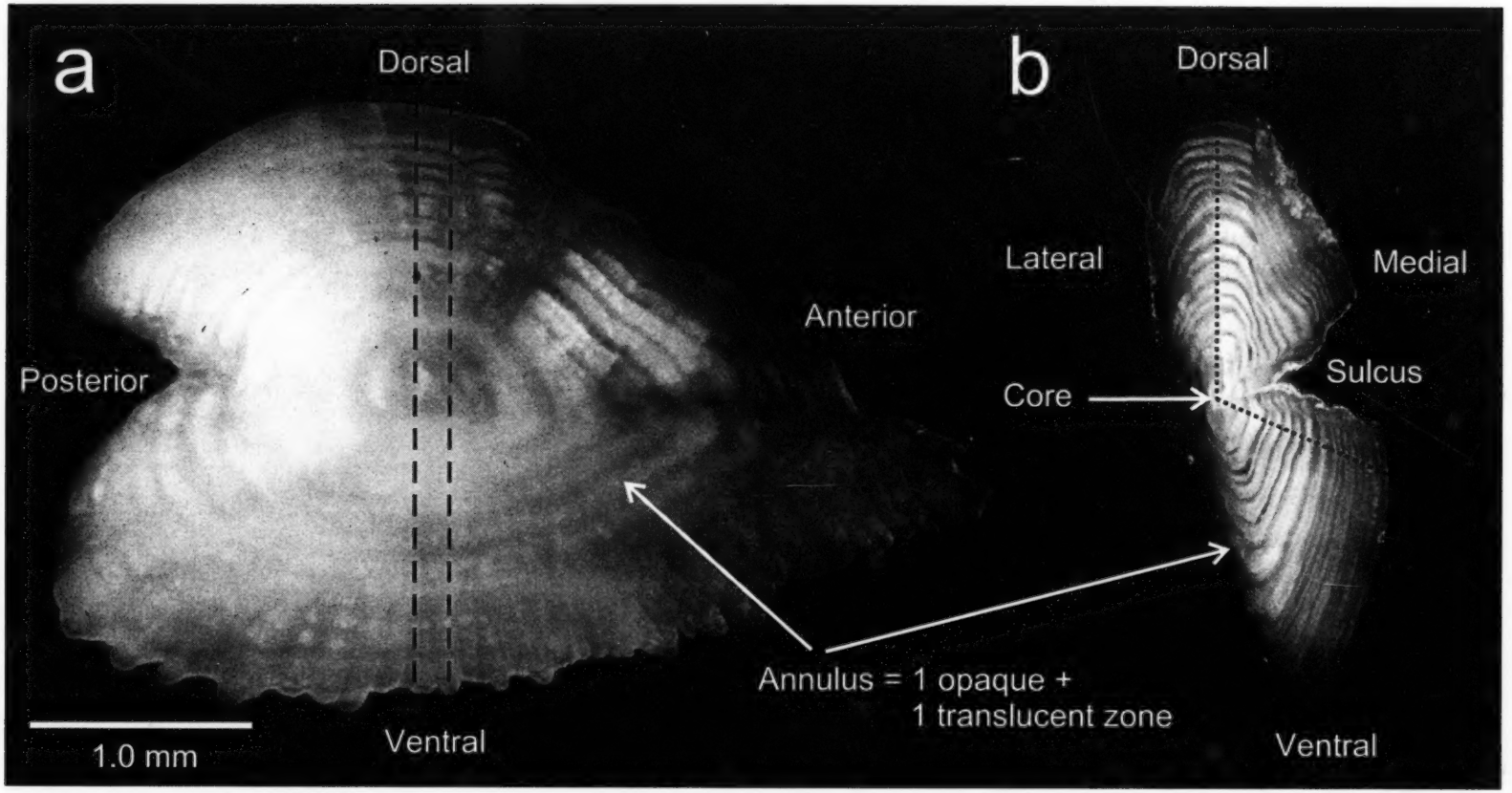


Figure 3. Typical Arctic char otolith showing the a) lateral side of its external surface; dashed lines indicate the transverse section taken to expose the internal surface for electron microprobe analysis and b) exposed surface of the otolith section showing typical transects (dotted lines) along which the analyses were conducted.

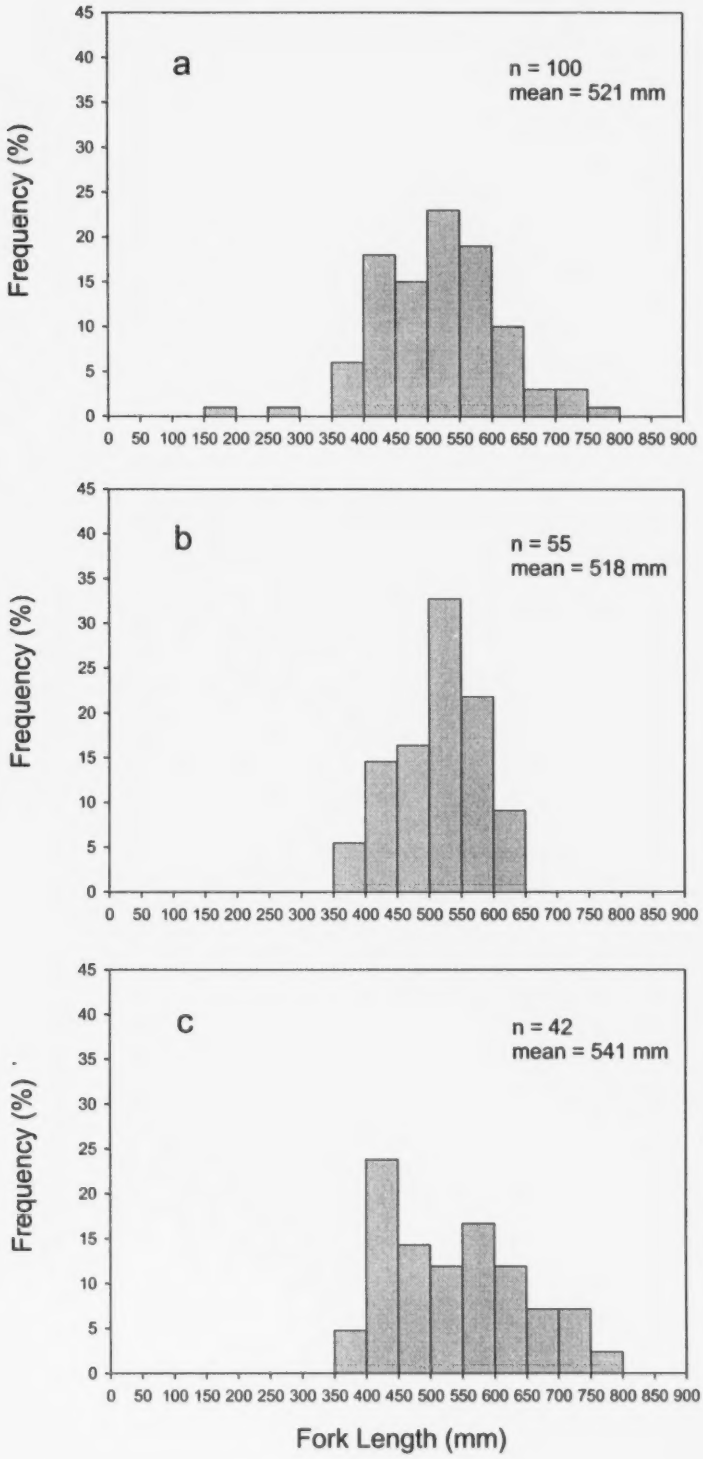


Figure 4. Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002.

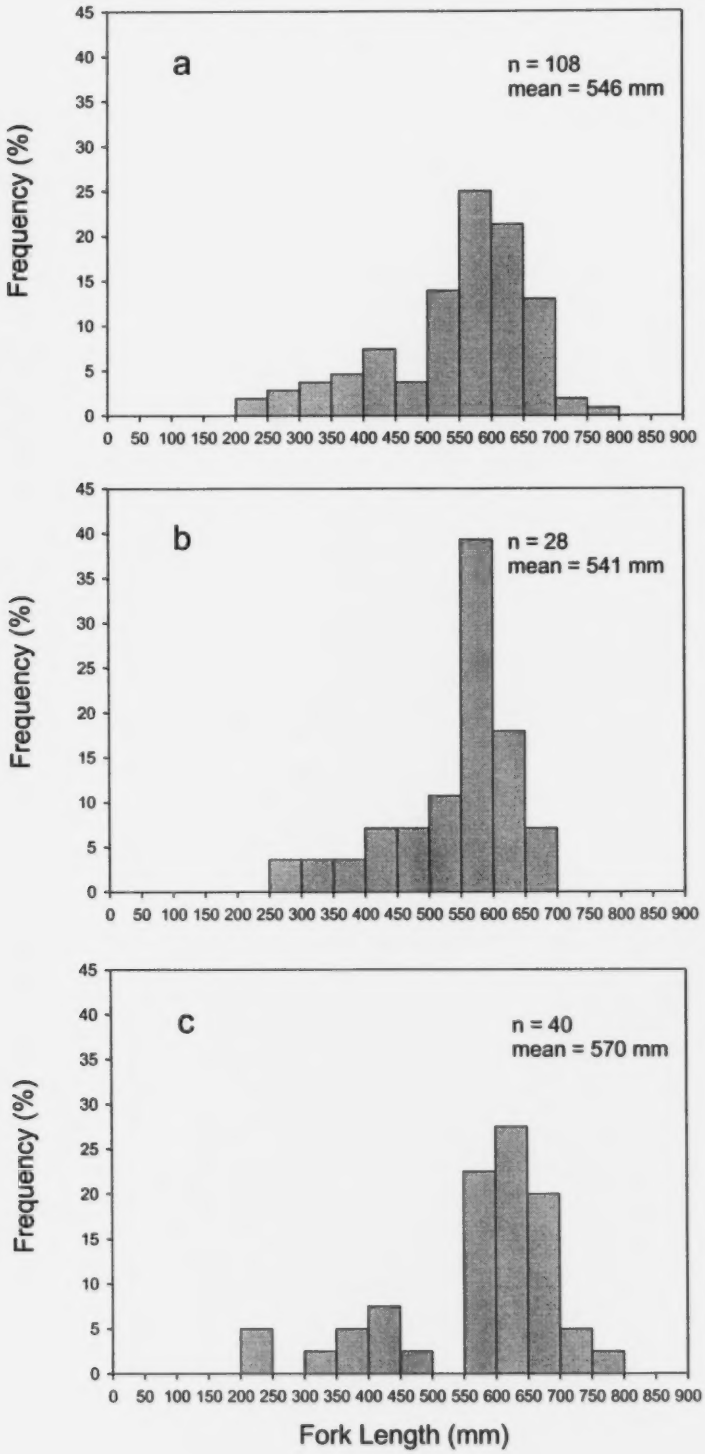


Figure 5. Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.

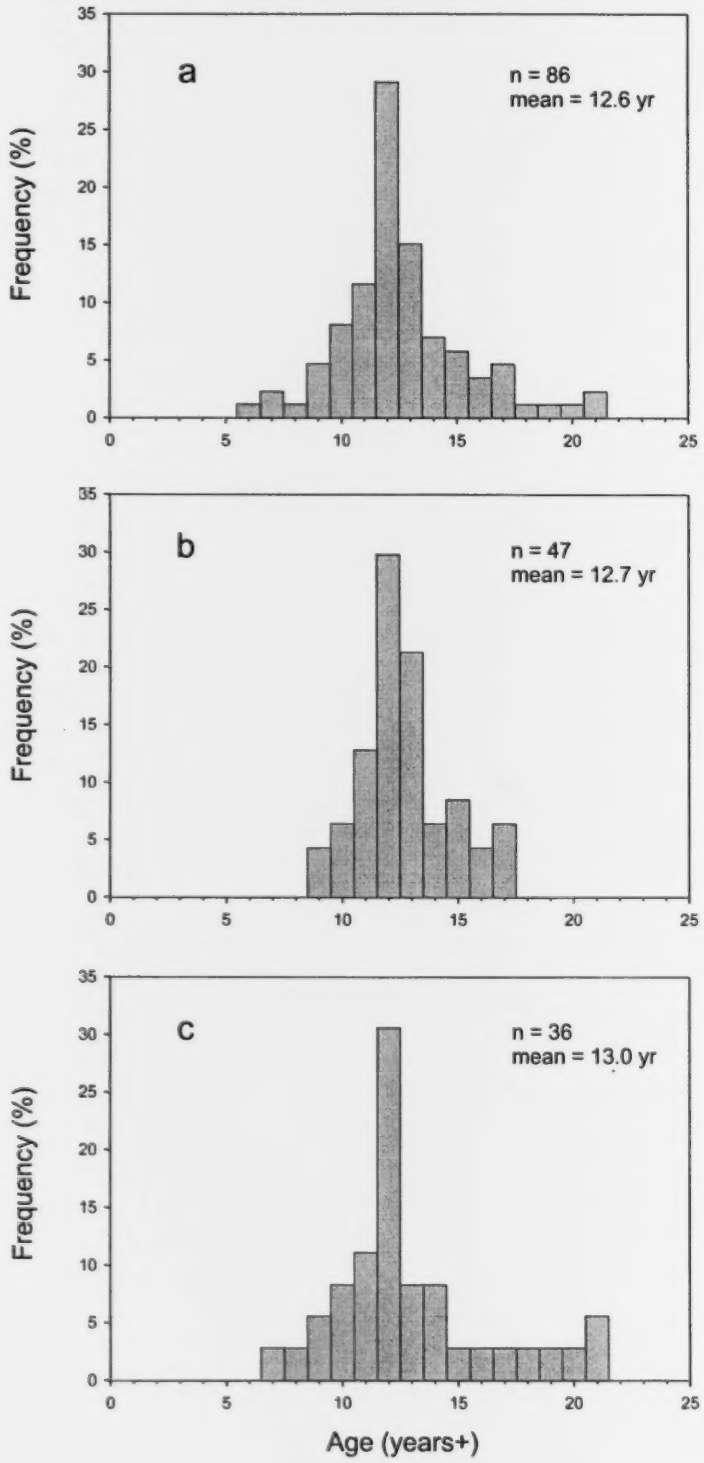


Figure 6. Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002.

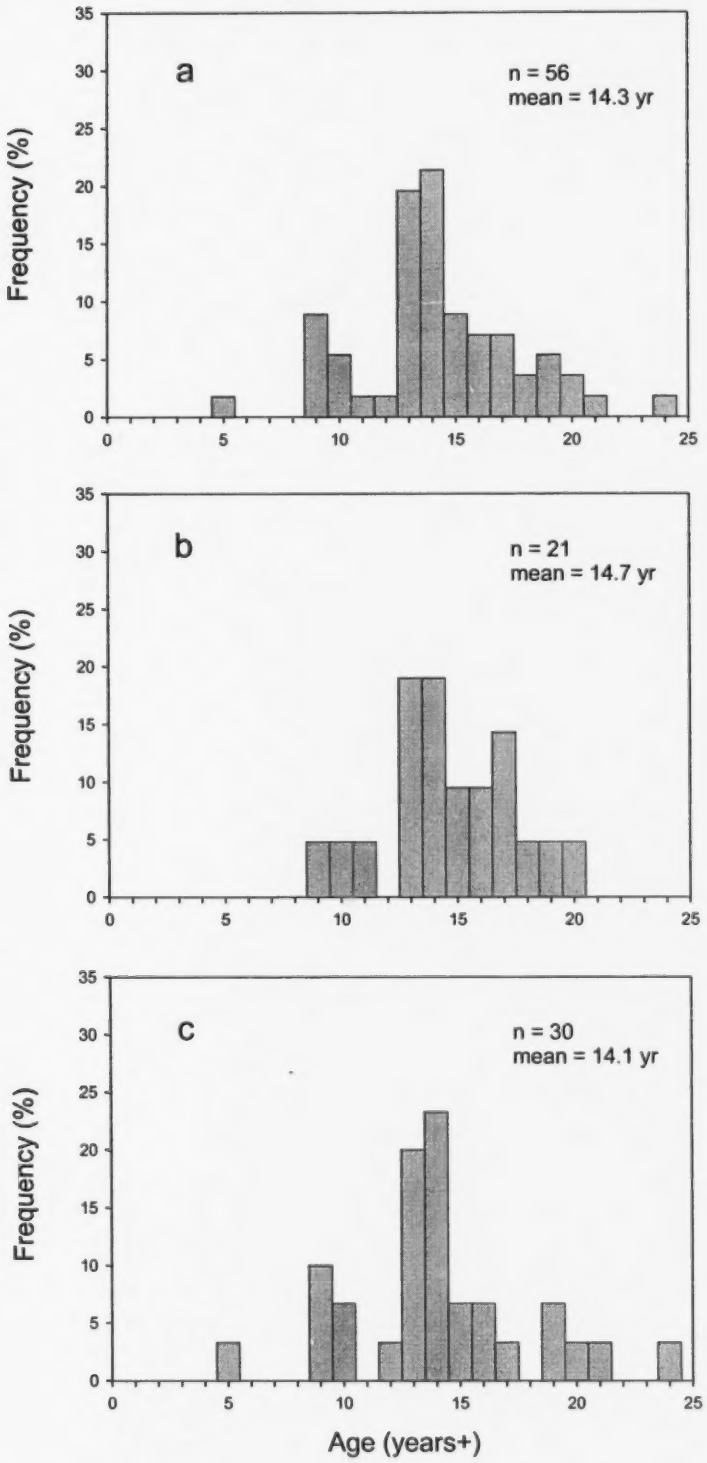


Figure 7. Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.

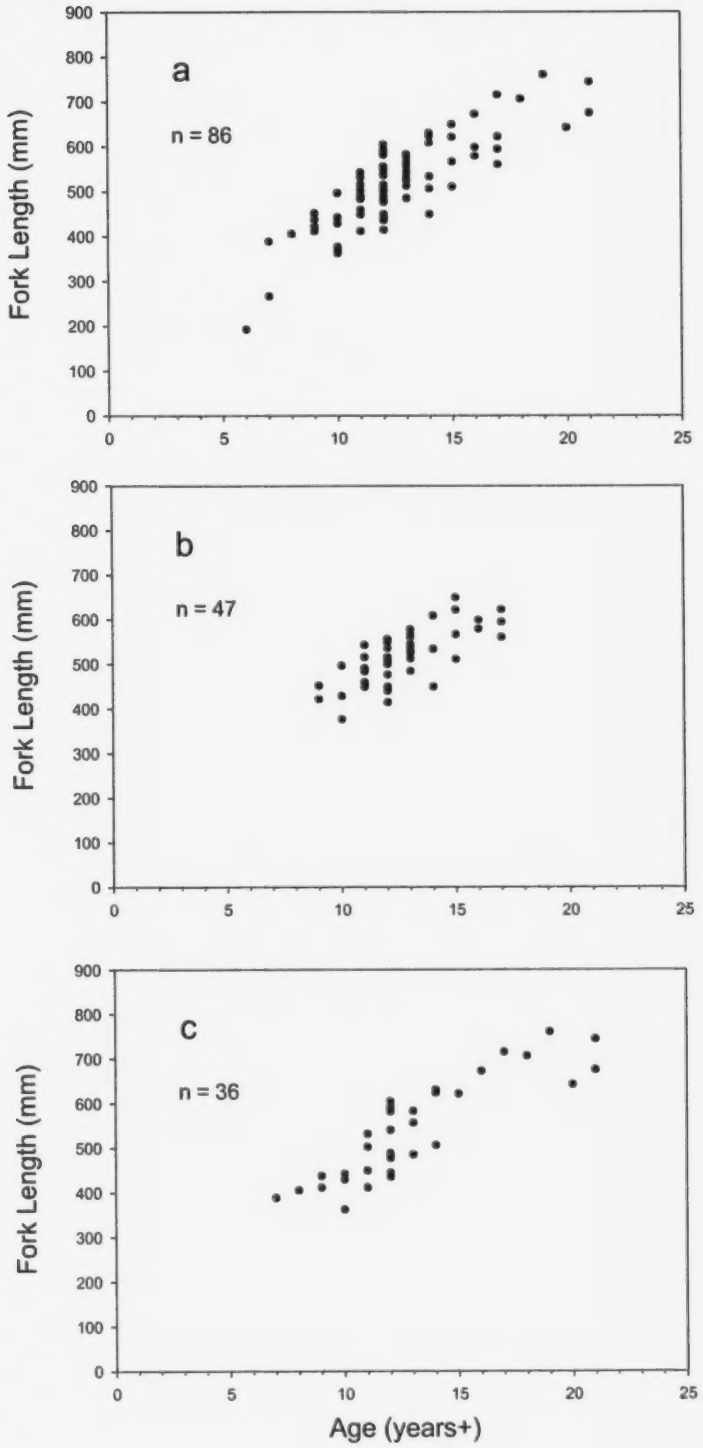


Figure 8. Relationship between fork length and age for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002.

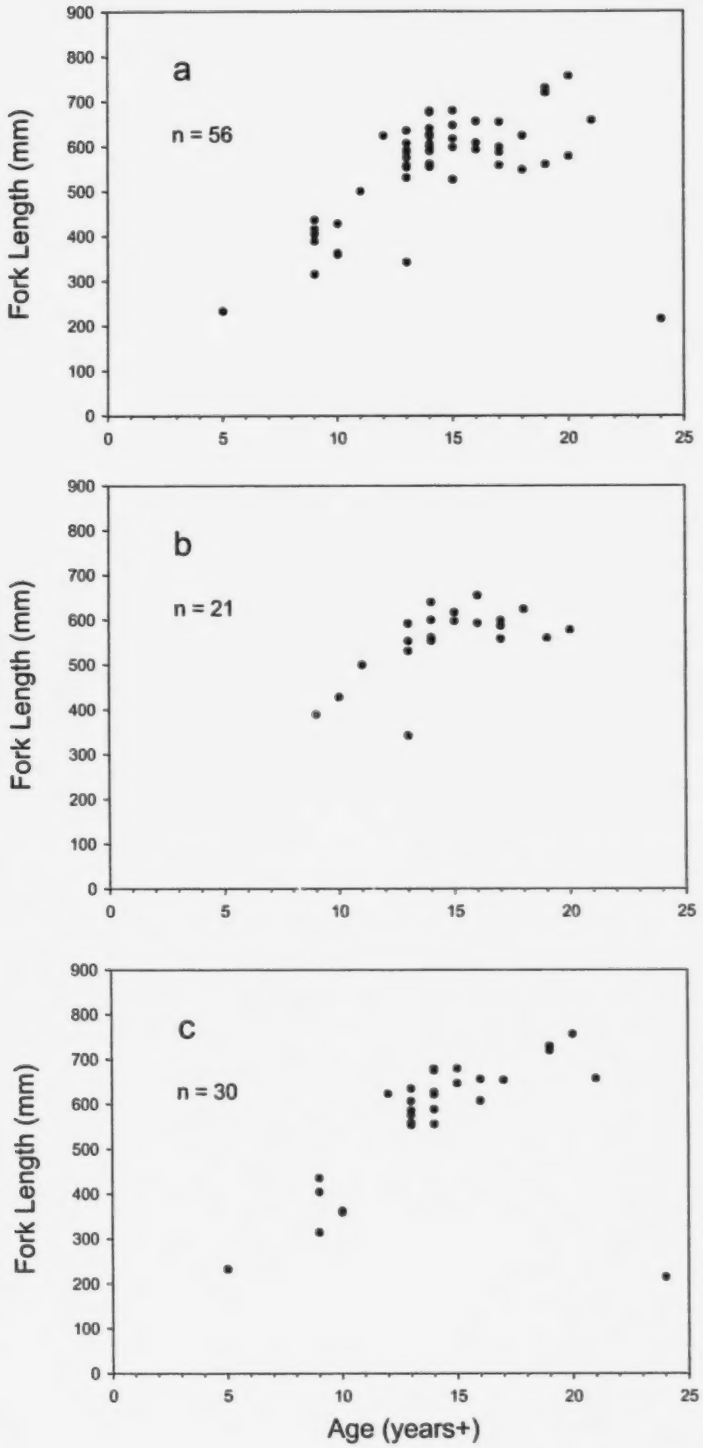


Figure 9. Relationship between fork length and age for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.

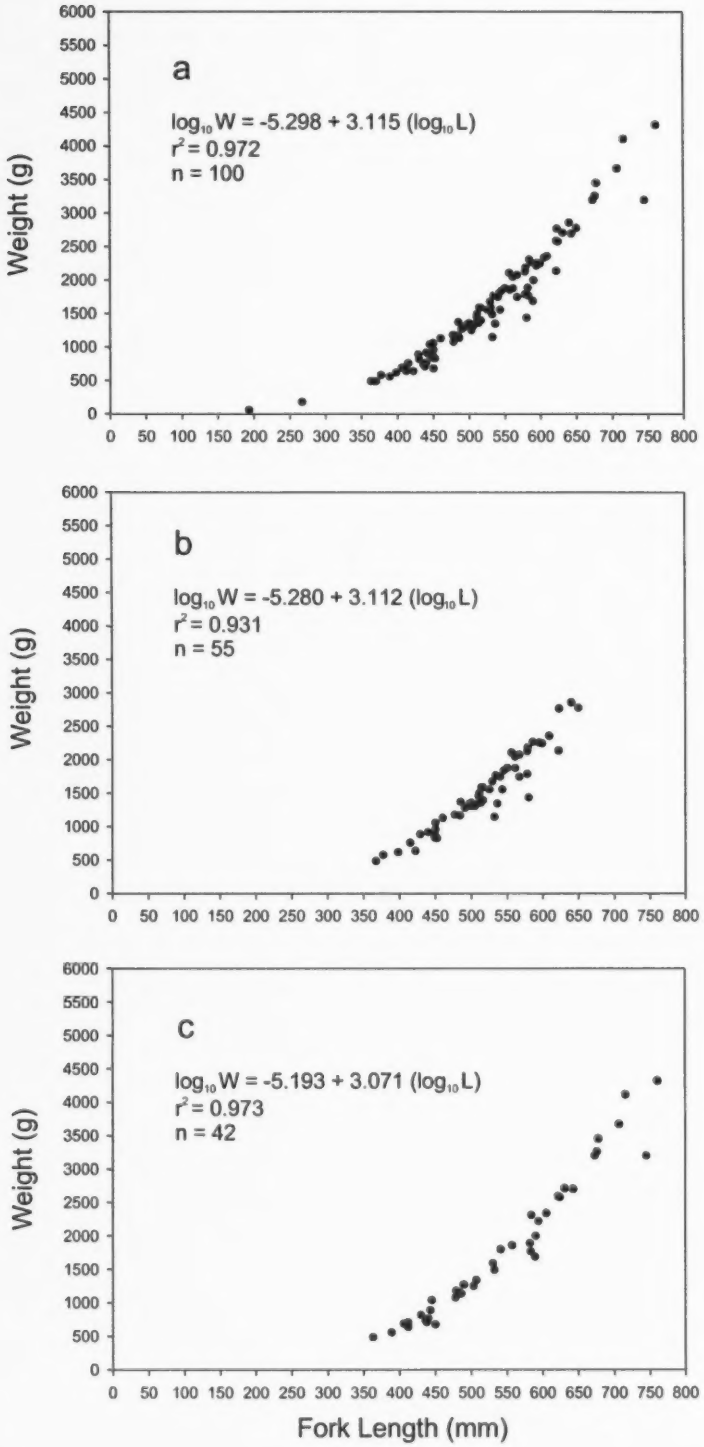


Figure 10. Relationship between weight and fork length for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002.

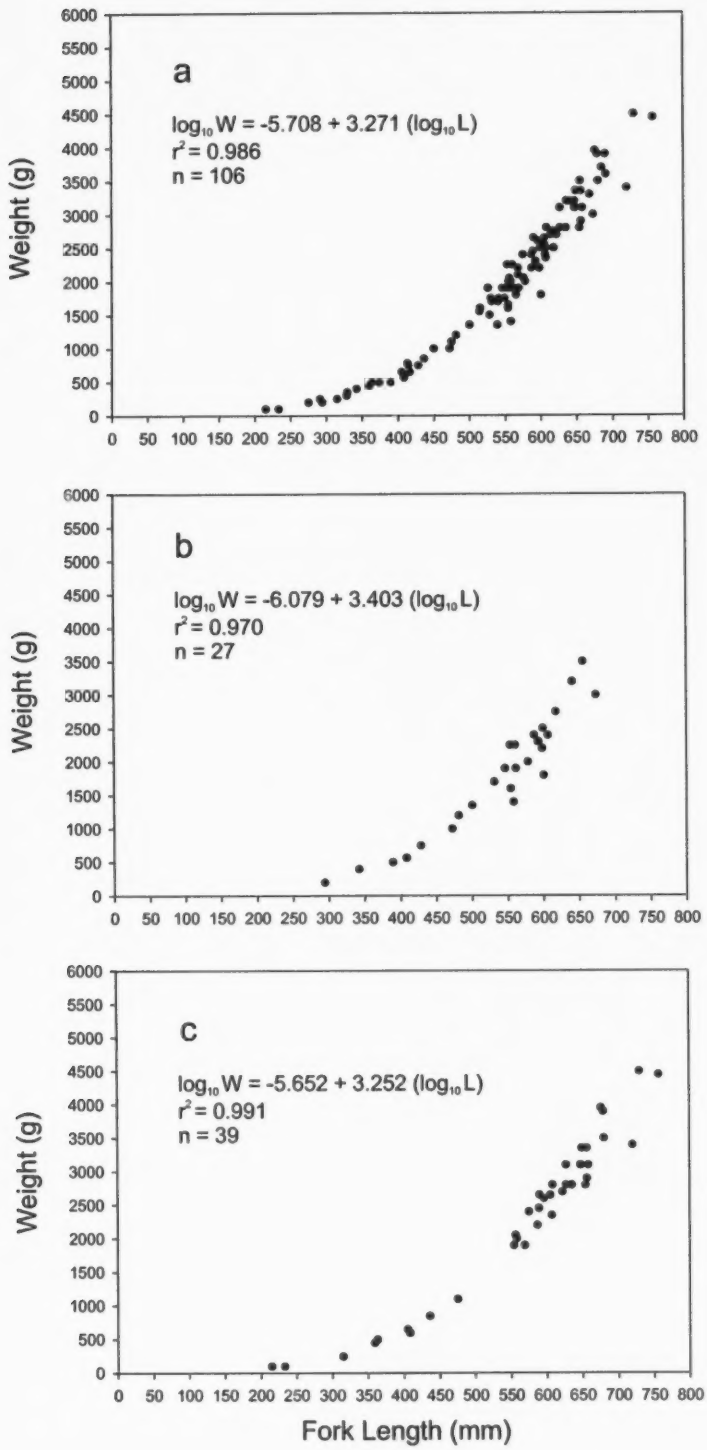


Figure 11. Relationship between weight and fork length for Arctic char (a) all fish, (b) females and (c) males from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.

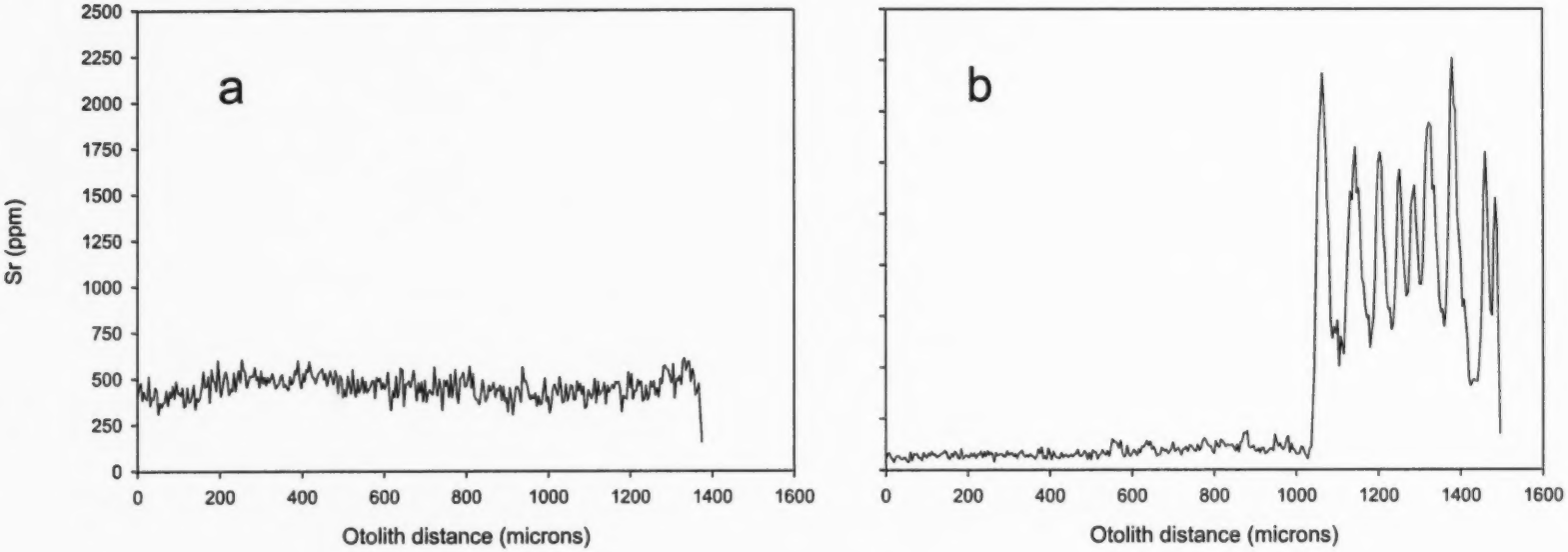


Figure 12. Typical strontium distribution profiles from scanning proton microprobe line-scans of an otolith collected from (a) a known non-anadromous Arctic char from Kilbourne Lake (Quttinirpaaq National Park, Ellesmere Island, Nunavut) and (b) a known anadromous Arctic char from Halovik River (Victoria Island, Nunavut).

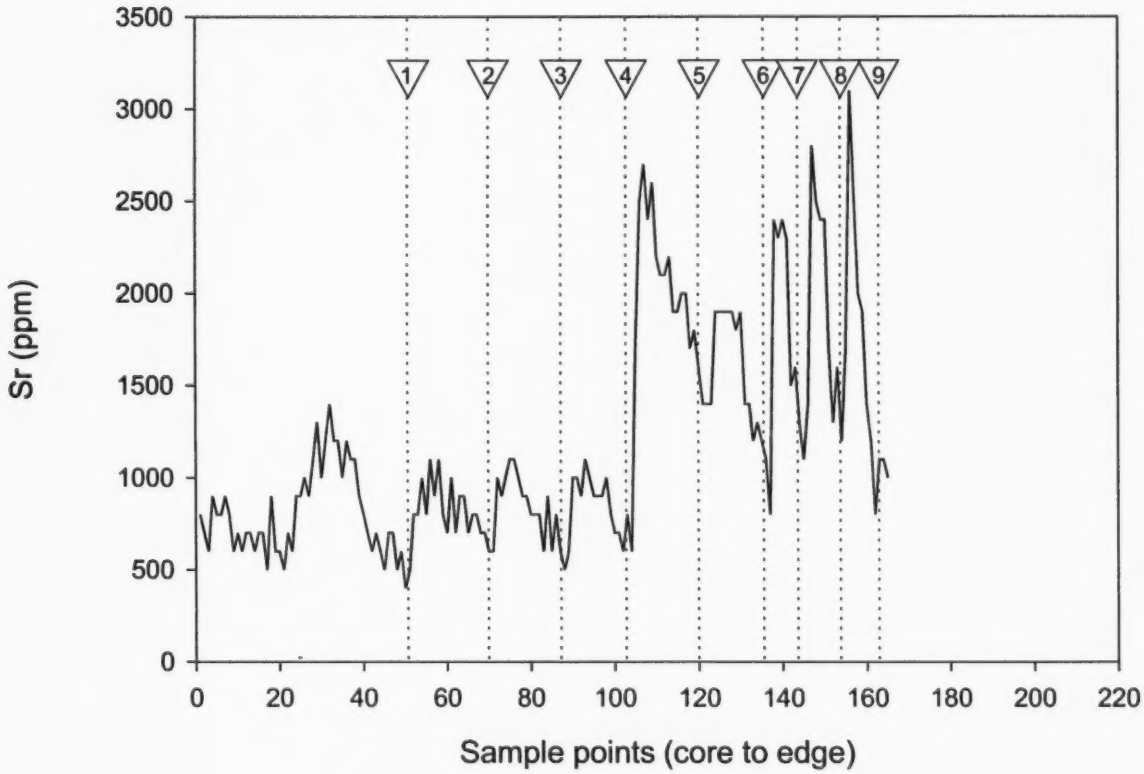


Figure 13. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#49013, 452 mm, 830 g, female, 9+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

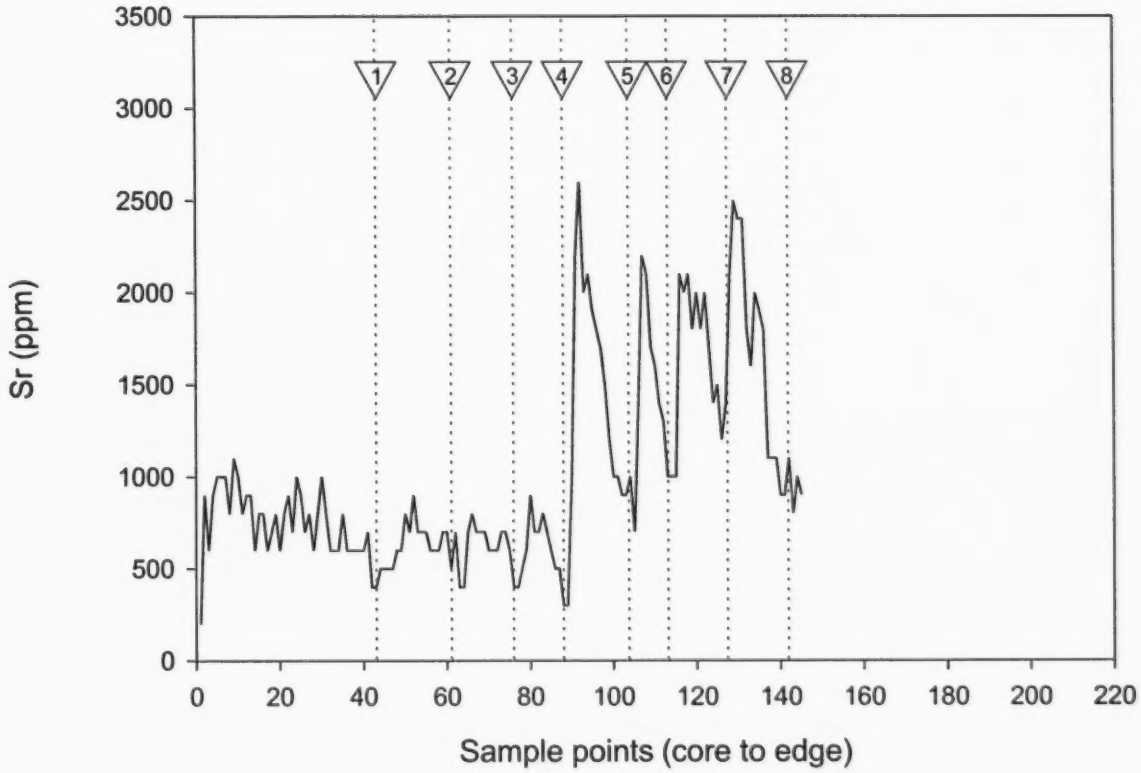


Figure 14. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48964, 406 mm, 690 g, male, 8+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

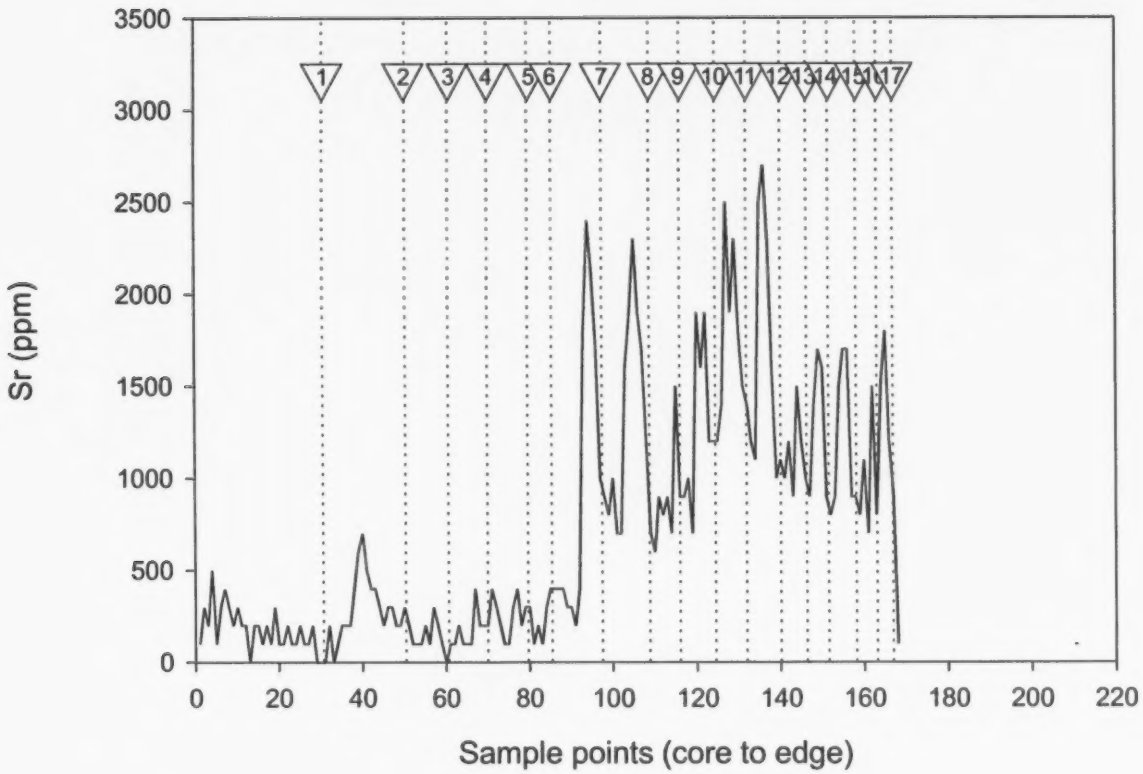


Figure 15. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48966, 595 mm, 2260 g, female, 17+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

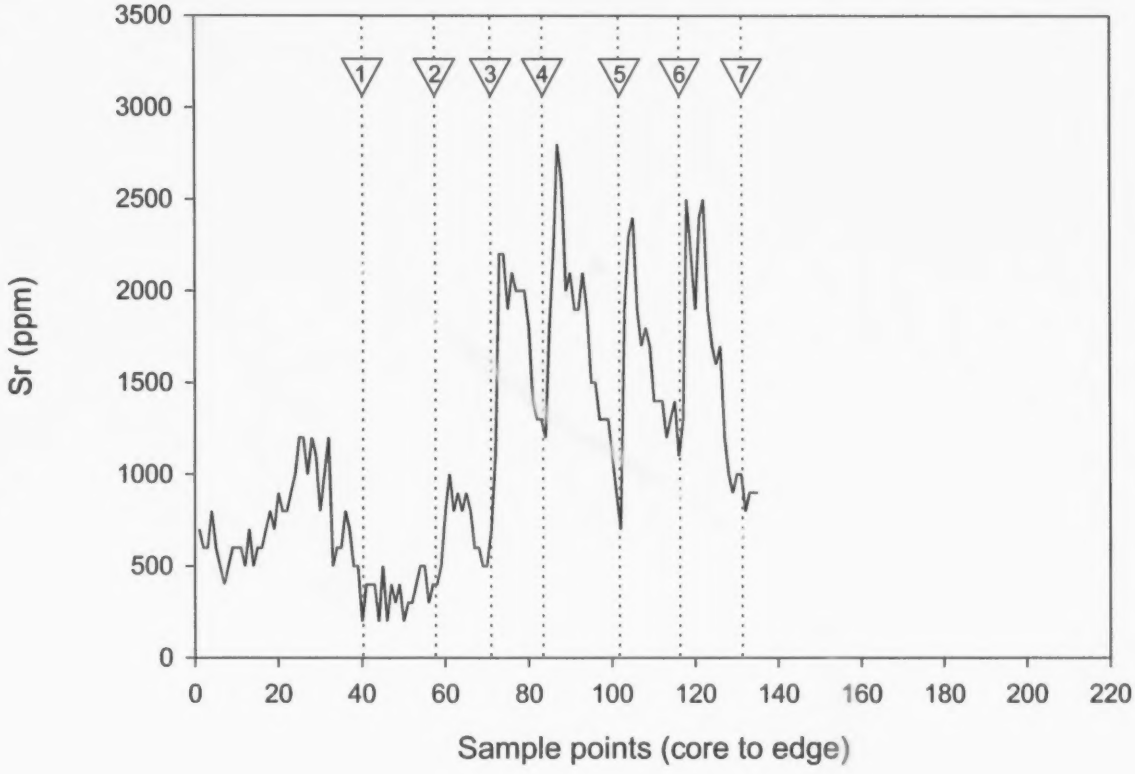


Figure 16. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48970, 389 mm, 560 g, male, 7+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

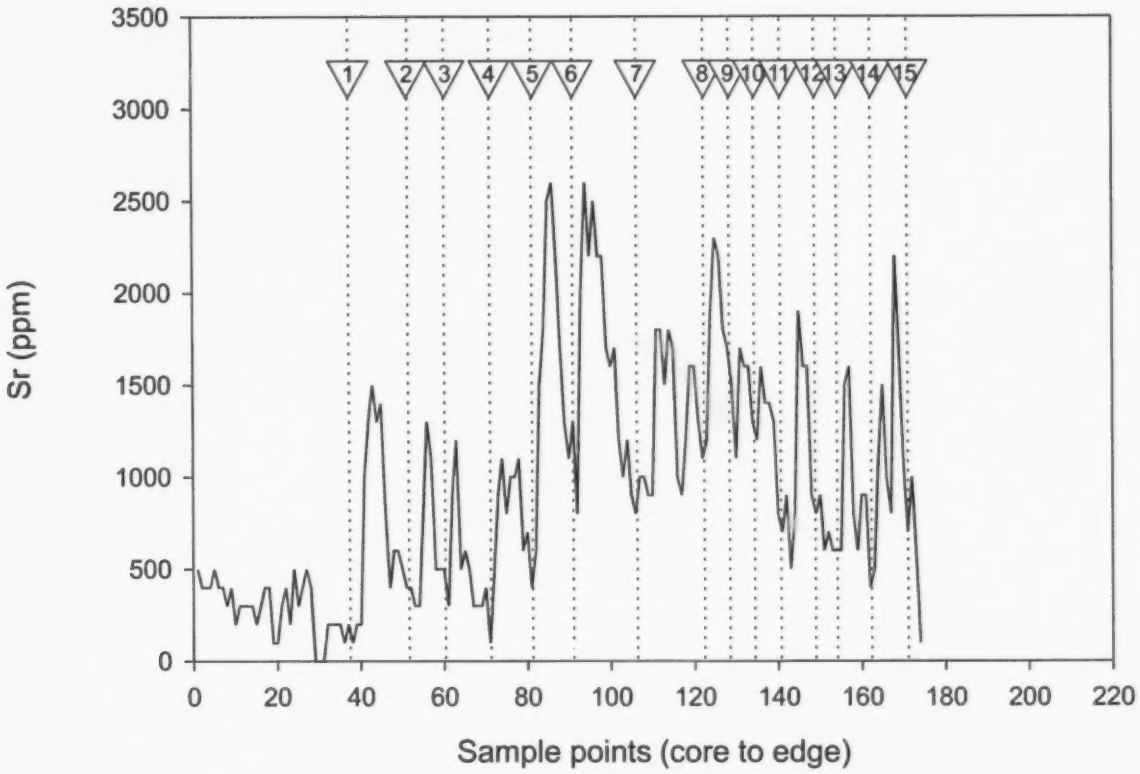


Figure 17. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48981, 595 mm, 2260 g, female, 15+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

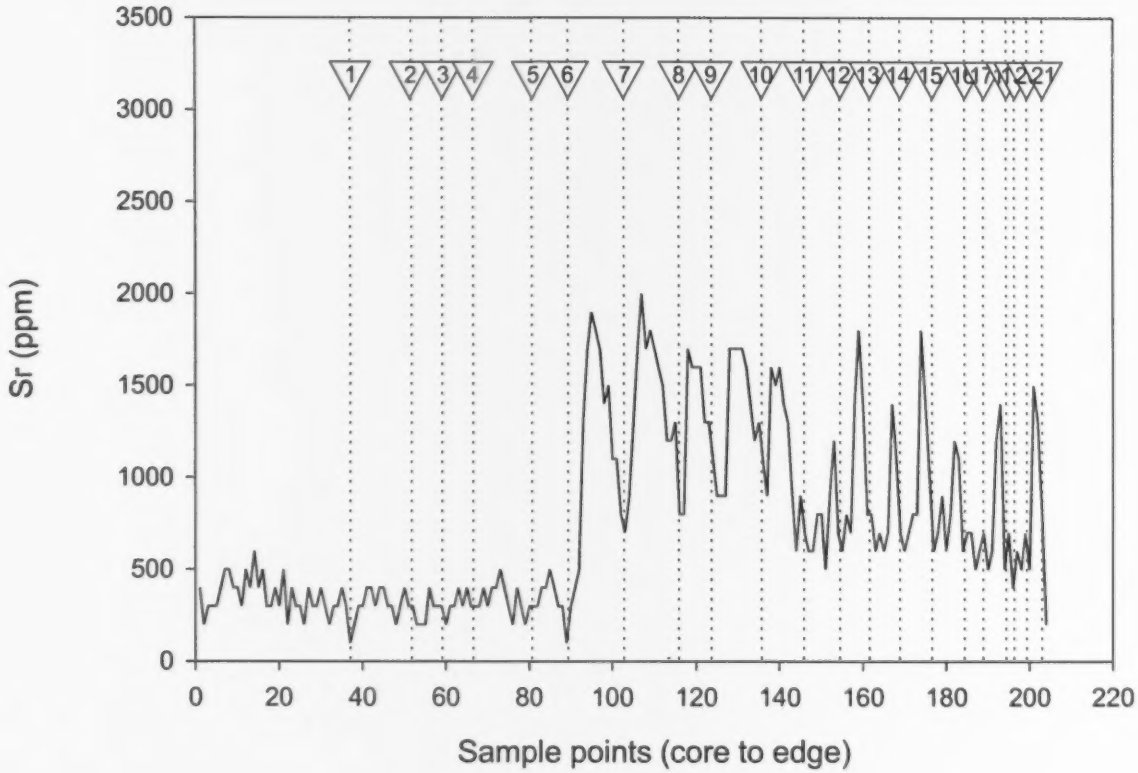


Figure 18. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48982, 676 mm, 3260 g, male, 21+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

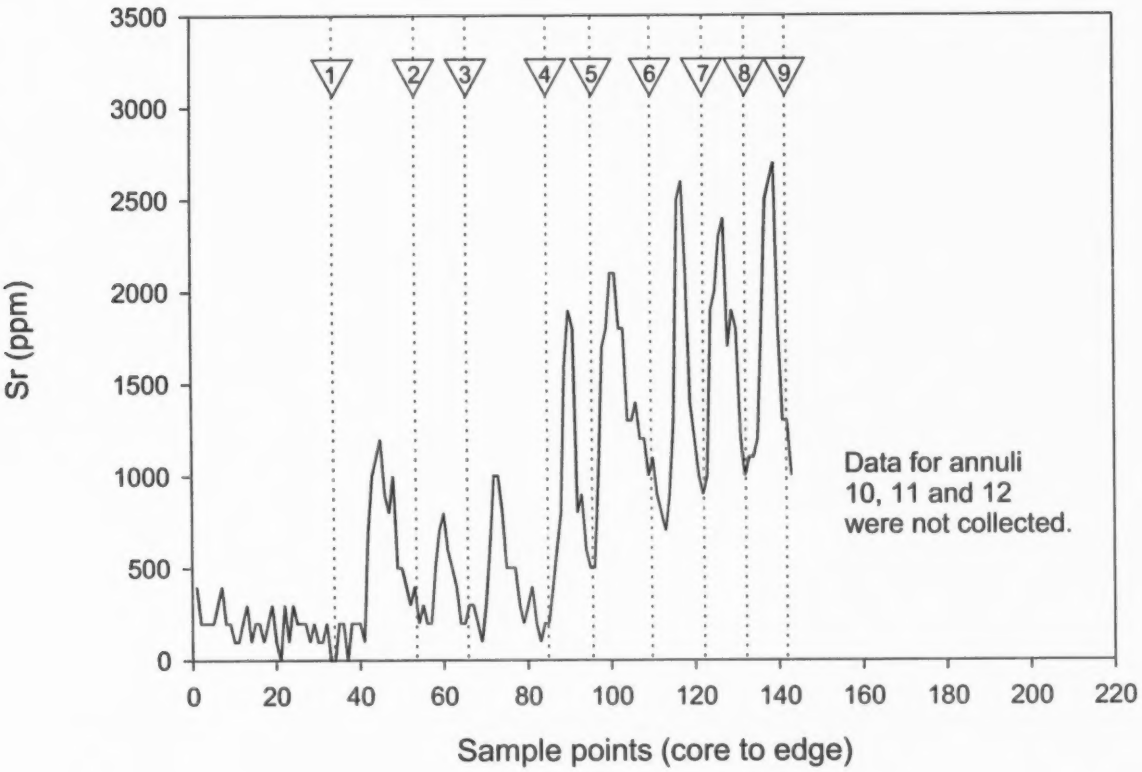


Figure 19. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48989, 516 mm, 1590 g, female, 12+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

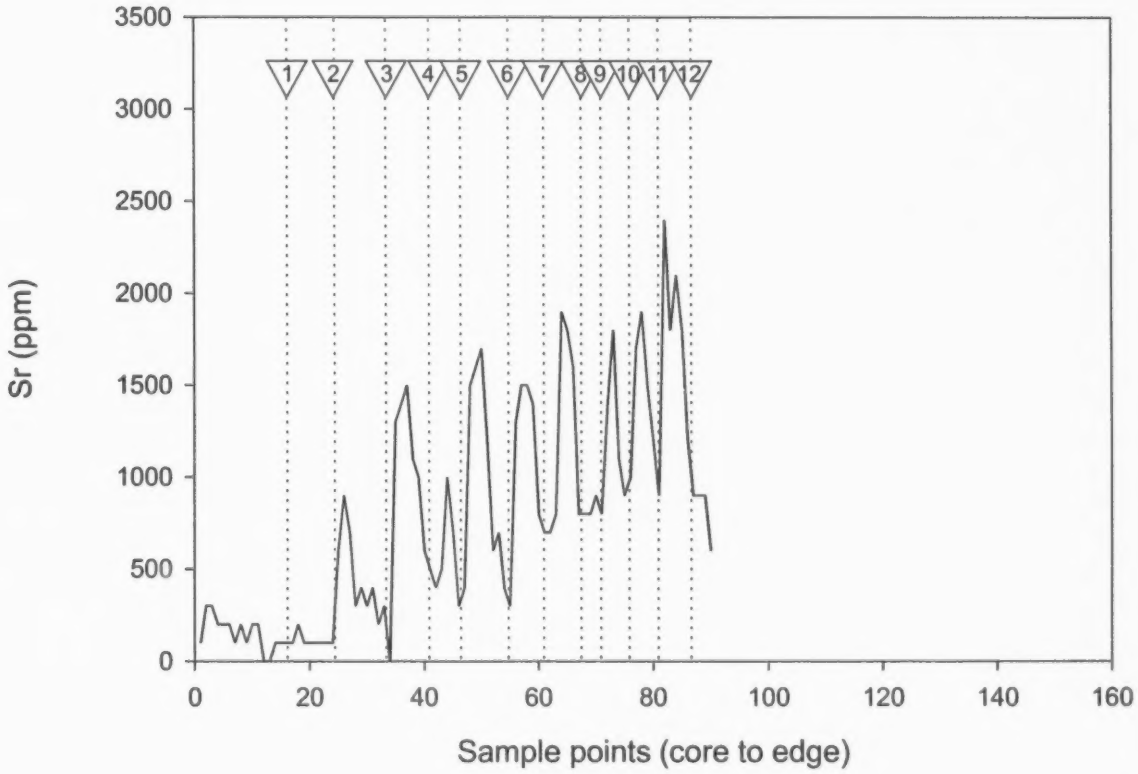


Figure 20. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48979, 415 mm, 760 g, female, 12+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

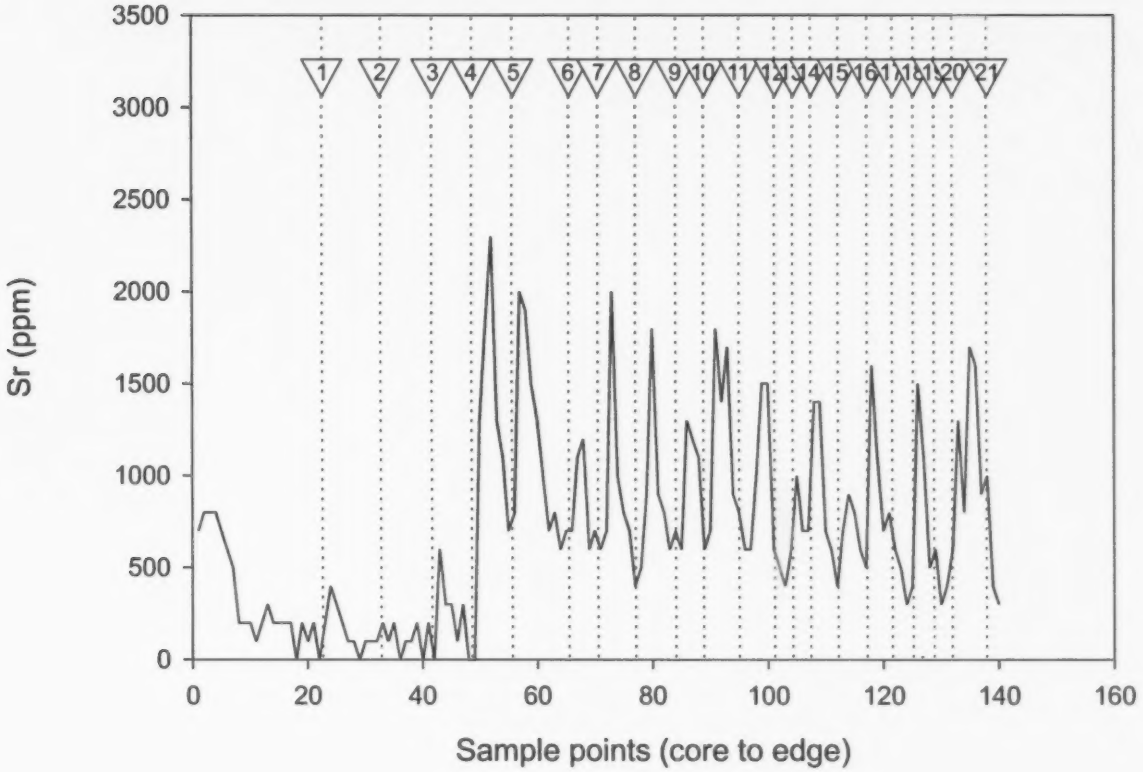


Figure 21. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#48996, 745 mm, 3200 g, male, 21+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

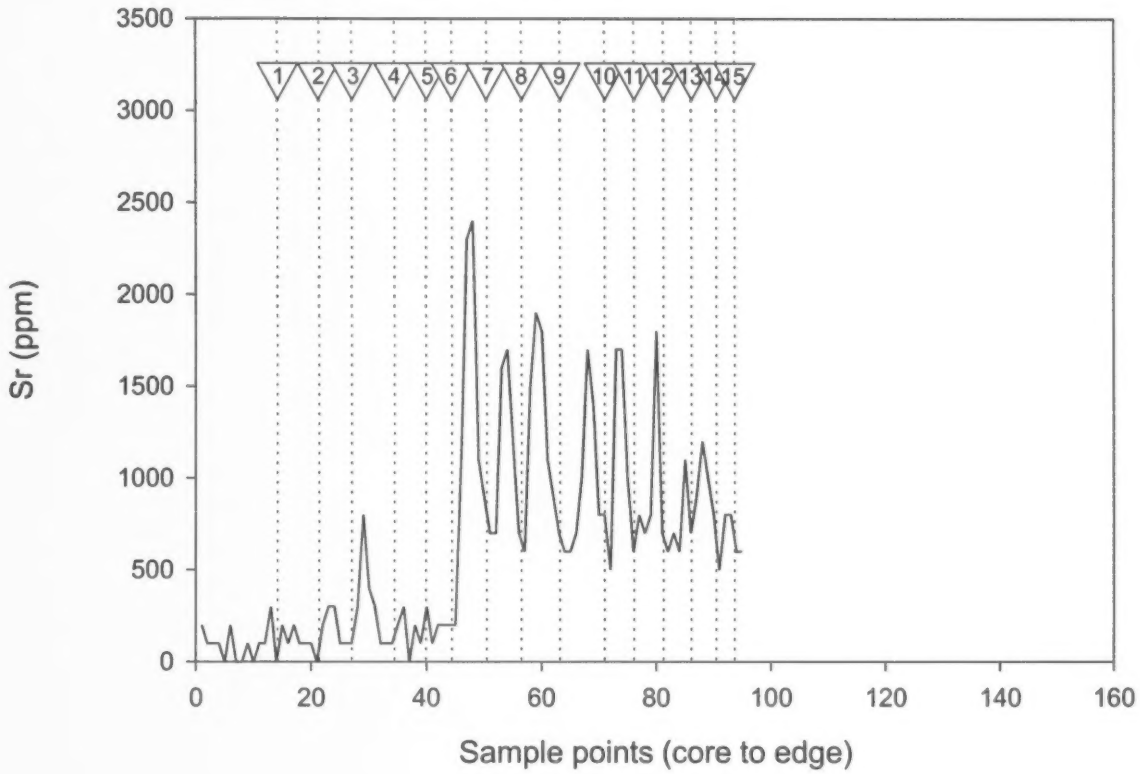


Figure 22. Strontium distribution profile from a wavelength-dispersive electron microprobe line-scan of an otolith from an Arctic char (#49036, 622 mm, 2590 g, male, 15+ yr) caught in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2002. Numbered triangles and dashed lines indicate approximate location of annuli.

Papiruq Fisheries Enterpize.
10th annual fishing derby.

May 21st 2004.

Travel to Lake #1Nadluqsiaq

May 22 2004.

First fish brought to papiruq tent. $300.00 any size.

Most fish *8:00am to9:00am*

All participants one prize qamutik with usivik from Housing

at 9:00am to 9:30Half hour break.

Longest fish *9:30am to 10:30am*

1st $500.00 grocery gift (CO-OP) from Hazco.
2nd 45 gallon gas with oils from CO-OP
3rd Sewing machine from CO-OP

Half hour break *10:30to11:00am*

Heaviest fish children *11:00to12:00pm*

1. For boy/girl 2 bicycles plus $50.00 each winner (youth committee)
   Ages up to 14 year old from Leelie Enterprise (bikes)

Lunch 1 hour. *12:00pmto1:00pm*

smallest fish *1:00pmto2:00pm*

1st Ottawa return ticket with $1,000.00
2nd $500.00 with 10 gallon gas
3rd $200.00

Heaviest fish starts

2:00to8:00pm & restarts Monday

May 23 2004

1:00pm feast Sunday.

May 24 2004

8:00am First fish brought to papirus tent $200.00 any size

Heaviest continue *8:00am to 12:00pm*

1st $8,000.00 plus 45 gallon gas with one case naptha
2nd $4,000.0
3rd. $2,000.00

May 25, 04 **7:00pm**derby prizes at gym 3 draws

ᐸᐱᑭᖅ 10ᓴᓐᓇ ᐃᖅᑲᓕᑐᐊᔪᐊᓂᓐ

ᒪᐃ 21 2004

ᖁᑭᖅᑕᓲᐊᒥ ᐊᐅᖅᓪᓗᓂᑦ ᓇᖅᓄᖅᐊᒍᓕ ᒥᔪᑎ

ᒪᐃ 22, 2004

ᑐᐱᒃᒍᐅᕐᓴᖅᑐᖅ ᐃᖅᑲᓕᑐᒥ ᐸᐱᑭᖅᑯᓄᓕ $300.00ᖅᓄᐃᕐᑐᐃᓇᖅᒥ

ᐊᒥᔪᔾᓪᓚᕐᓯᓂᖅ ***8:00ᒥ 9:00ᒍᑦ*** **ᐃᖅᓴᓗᔪᓕᑐᒥᓄᑦ**

ᐊᑕᐅᔪᖅᒍᑦ ᖁᓴᒥᑎ ᐅᔪᕕᖅᑕᐅᑎᑎᔪᖅ ᐃᓪᓗᑐᓪᓚᕐᓴᐅᓂᖅ.

9:00ᒥ 9:30ᒍ ᓄᖅᖃᓴᓴᐃᓇᓪᓗᑎᓄᑦ

ᑕᑭᓪᒥᑦ ᐃᖅᓴᓗᑦᑐᐅᑎᓂᖅ ***9:30ᒥ 10:30ᒍ.***

1st $500.00 ᓂᖅᑭᑕᑎᑎ (ᑯᐊᐸᐸᑯᓂ) ᕿᐅᑯᐃᓂᑦ ᑐᓂᔾᖅ

2nd ᖁᑦᑕᐅᔾᖅᖅ ᐃᓪᓚᔾᖁᑦᑕᐅᑎᑎᔪᖅ

3rd ᒥᖅᑎᑎ ᑯᐊᐸᖁᐃᓂᓂ

10:30ᒥ 11:00 ᓄᖅᖁᖅᓴᓴᐃᓇᓪᓗᕐᔾ

ᐅᖅᑯᒪᐃᓪᓚᕐᓯᓂᑐᑎ ᓯᑎᓯᑦ ***11ᒥ 12ᒍ.***

ᐊᖅᑎᑎᒍᑦ/ᐊᖅᓇᒧᓗ ᒪᖅᐳᖅ ᑐᖅᖁᓗᐊᓪᓚᖅ ᐊᓕᒪ$50.00ᐊᑐᓂ (ᐃᓄᓯᑐᑯᓂᑦ)

14ᒥ ᐊᑕᓄ ᐅᑭᐅᓪᓂᓄᑦ ᓪᓚᐅᑦ ᓂᐅᔾᔨᐃᓴᖅᓯᓂᕐᑐᖁᓗᐊᓪᓚᖅ)

ᐃᖁᖅᕐᒥ ᐊᑕᐅᔪᖅᒥ ᓂᓗᓴᓓ 12:00ᓕ 1:00ᐅᓴᓕᓴᓂᑦ

ᑎᑭᓪᒥ ᐃᖅᑲᓗᓕᔪᓂᖅ ***1:00ᒥ 2:00ᒍ***

1st ᐊᑐᓀᒍᑦ ᖁᖅᓴᓕᑕᑎᑎ ᐅᑎᐅᑎᑎ ᐊᓕᒪ $1,000.00

2nd $500.00 ᐊᓕᒪ 10ᑲᓪ ᐄᓂ

3rd $200.00

ᐅᖅᑯᒪᐃᓪᓚᕐᓯᓂᔪᖅ ᐱᑎᐊᖅᑐᖅ

2ᒥ 8ᒍ ᑲᔪᓂᑲᓂᑐᓂ ᓇᓴᓕᐅᒥ

ᒪᐃ 23, 2004

1:00ᒥᑦ ᓂᓚᖅᑲᑎᑎᓂ ᓇᑎᐅᔾᔪᓕᒥ.

ᒪᐃ 24, 2004.

8:00ᒥ ᑐᐱᒃᒍᐅᕐᓴᖅᑐᖅ ᐃᖅᑲᓗᒥᑦ ᐸᐱᑭᔾᓄ $200.00

ᐅᖅᑯᒪᐃᓪᓚᕐᓯᓂᓂᖅ ᑲᔪᓯᔪᖅᖅ ***8:00ᒥ 12:00ᒍ***

1st $8,000.00 ᐊᓕᒪ 45 ᖁᑦᑕᐅᔾᖅ ᐄᓂ ᐊᓕᒪ ᖁᑦᓯᓂᓯᐅᑎᑦ ᐃᓪᓗᐃᑐᖅᖅ

2nd $4,000.00

3rd $2,000.00

ᒪᐃ 25,04 7:00ᒥ ᕿᓪᓴᐅᔪᓯᓂᓂᖅ 3ᓂ ᐊᒍᔪᖁᑕᓗᑎᑦ

Appendix 1. Information pamphlet provided to 2004 Qikiqtarjuaq fishing derby participants by derby organizers.

Appendix 2. Field sample and laboratory processing numbers, fork lengths, weights, sex, otolith ages, and condition factors for Arctic char captured in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002.

Field Sample No.	Laboratory Processing No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
1	49002	440	920	F	12	1.080	
2	48990	678	3450	M	-	1.107	No otoliths collected
3	49023	536	1350	F	12	0.877	
4	49008	513	1380	F	13	1.022	
5	48972	482	1170	M	12	1.045	
6	49005	550	1880	F	12	1.130	
7	48979	415	760	F	12	1.063	
8	48998	449	870	F	11	0.961	
9	49037	490	1270	M	-	1.079	No otoliths collected
10	48992	500	1360	F	12	1.088	
11	49038	640	2860	F	-	1.091	No otoliths collected
12	49003	450	1060	F	14	1.163	
13	49001	489	1270	M	12	1.086	
14	48993	510	1460	F	12	1.101	
15	49031	561	1880	F	17	1.065	
16	49030	511	1500	F	-	1.124	Otoliths unreadable
17	48999	430	820	M	10	1.031	
18	48988	484	1170	F	11	1.032	
19	48986	580	1440	F	16	0.738	
20	48953	567	1750	F	13	0.960	
21	49028	590	2000	M	12	0.974	
22	49039	398	620	F	-	0.983	No otoliths collected
23	49014	363	490	M	10	1.024	
24	49013	452	830	F	9	0.899	
25	49040	586	2270	F	-	1.128	No otoliths collected
26	48995	578	2130	F	13	1.103	
27	49019	500	1310	F	12	1.048	
28	49021	540	1750	F	13	1.111	
29	49041	578	1790	F	-	0.927	No otoliths collected
30	49007	436	740	M	12	0.893	
31	49034	543	1560	F	11	0.974	
32	49004	514	1590	F	12	1.171	
33	49000	443	890	M	10	1.024	
34	49016	438	710	M	9	0.845	
35	48987	497	1340	F	10	1.092	
36	48975	567	2080	F	15	1.141	
37	48950	557	1860	M	13	1.076	
38	49029	513	1360	F	13	1.007	
39	48980	609	2360	F	14	1.045	
40	49033	532	1150	F	13	0.764	
41	48989	516	1590	F	12	1.157	
42	48952	583	1770	M	13	0.893	
43	49015	599	2250	F	16	1.047	
44	49020	460	1130	F	11	1.161	
45	48991	716	4110	M	17	1.120	

Appendix 2. Continued.

Field Sample No.	Laboratory Processing No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
46	48996	745	3200	M	21	0.774	
47	49018	193	60	U	6	0.835	
48	49036	622	2590	M	15	1.076	
49	49006	534	1770	F	14	1.162	
50	48948	541	1800	M	12	1.137	
51	49022	505	1310	F	12	1.017	
52	49042	529	1680	F	-	1.135	No otoliths collected
53	49032	507	1340	M	14	1.028	
54	49025	643	2700	M	20	1.016	
55	48994	491	1280	F	11	1.081	
56	49027	556	2110	F	12	1.228	
57	49024	545	1840	F	13	1.137	
58	49011	673	3200	M	16	1.050	
59	48983	367	490	F	-	0.991	Otoliths unreadable
60	48984	429	890	F	10	1.127	
61	49043	530	1590	M	-	1.068	No otoliths collected
62	49012	707	3670	M	18	1.039	
63	49010	623	2770	F	17	1.146	
64	49009	485	1370	F	13	1.201	
65	49035	594	2220	M	12	1.059	
66	49017	267	180	U	7	0.946	
67	48968	450	960	F	12	1.053	
68	49026	449	840	F	12	0.928	
69	48960	605	2340	M	12	1.057	
70	48976	377	580	F	10	1.082	
71	48955	761	4320	M	19	0.980	
72	48997	370	490	U	10	0.967	
73	48964	406	690	M	8	1.031	
74	49044	589	1690	M	-	0.827	No otoliths collected
75	48961	440	770	M	-	0.904	Otoliths unreadable
76	48967	412	710	M	11	1.015	
77	48966	595	2260	F	17	1.073	
78	48954	622	2140	F	15	0.889	
79	48974	477	1180	F	12	1.087	
80	48957	582	1890	M	12	0.959	
81	48985	532	1490	M	11	0.990	
82	48977	422	640	F	9	0.852	
83	48973	503	1250	M	11	0.982	
84	48963	511	1380	F	15	1.034	
85	48978	478	1080	M	12	0.989	
86	48971	525	1560	F	13	1.078	
87	48949	584	2310	M	12	1.160	
88	48959	450	680	M	11	0.746	
89	48951	631	2710	M	14	1.079	
90	49045	579	2190	F	-	1.128	No otoliths collected
91	48962	412	640	M	9	0.915	
92	48958	516	1400	F	11	1.019	
93	48956	624	2580	M	14	1.062	

Appendix 2. Continued.

Field Sample No.	Laboratory Processing No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
94	48947	561	2050	F	13	1.161	
95	48982	676	3260	M	21	1.055	
96	48970	389	560	M	7	0.951	
97	48965	486	1140	M	13	0.993	
98	48969	445	1040	M	12	1.180	
99	48981	650	3780	F	15	1.012	
100	49046	479	1180	M	-	1.074	No otoliths collected

Appendix 3. Field sample and laboratory processing numbers, fork lengths, weights, sex, otolith ages, and condition factors for Arctic char captured in Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004.

Field Sample No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
1	640	3200	F	14	1.221	
2	408	600	M	-	0.883	No otoliths collected
3	590	2650	M	-	1.290	No otoliths collected
4	569	1900	M	-	1.031	No otoliths collected
5	598	2200	F	15	1.029	
6	568	2200	-	-	1.201	No otoliths collected
7	673	3000	F	-	0.984	No otoliths collected
8	528	1500	-	-	1.019	No otoliths collected
9	472	1000	F	-	0.951	No otoliths collected
10	601	2500	-	-	1.152	No otoliths collected
11	528	1500	-	-	1.019	No otoliths collected
12	549	1750	-	-	1.058	No otoliths collected
13	618	2500	-	-	1.059	No otoliths collected
14	408	565	F	-	0.832	No otoliths collected
15	416	650	-	9	0.903	
16	636	3200	-	-	1.244	No otoliths collected
17	450	1000	-	-	1.097	No otoliths collected
18	275	200	-	-	0.962	No otoliths collected
19	328	300	-	-	0.850	No otoliths collected
20	329	350	-	-	0.983	No otoliths collected
21	481	1200	F	-	1.078	No otoliths collected
22	363	500	M	10	1.045	
23	549	1750	-	-	1.058	No otoliths collected
24	414	750	-	-	1.057	No otoliths collected
25	359	450	-	-	0.973	No otoliths collected
26	500	1350	F	11	1.080	
27	373	500	-	-	0.963	No otoliths collected
28	233	100	M	5	0.791	
29	554	1600	F	14	0.941	
30	556	1900	-	-	1.105	No otoliths collected
31	291	250	-	-	1.015	No otoliths collected
32	389	500	F	9	0.849	
33	413	780	-	-	1.107	No otoliths collected
34	359	450	M	10	0.973	
35	514	1550	-	-	1.141	No otoliths collected
36	541	1750	-	-	1.105	No otoliths collected
37	515	1600	-	-	1.171	No otoliths collected
38	605	2650	M	-	1.197	No otoliths collected
39	656	3350	M	-	1.187	No otoliths collected
40	649	3350	M	-	1.225	No otoliths collected
41	648	3100	M	-	1.139	No otoliths collected
42	593	2300	F	16	1.103	
43	546	1900	F	-	1.167	No otoliths collected
44	599	2500	F	17	1.163	
45	676	3950	M	14	1.279	

Appendix 3. Continued.

Field Sample No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
46	600	1800	F	14	0.833	
47	624	-	M	12	-	
48	680	3500	M	15	1.113	
49	558	1400	F	17	0.806	
50	655	3500	F	16	1.246	
51	635	2800	M	13	1.094	
52	605	2550	-	14	1.152	
53	606	2400	F	-	1.078	No otoliths collected
54	558	2000	M	13	1.151	
55	757	4450	M	20	1.026	
56	658	3100	M	21	1.088	
57	720	3400	M	19	0.911	
58	654	2800	M	17	1.001	
59	554	1900	M	13	1.117	
60	428	750	F	10	0.957	
61	315	250	M	9	0.800	
62	560	2250	F	19	1.281	
63	690	3900	-	-	1.187	No otoliths collected
64	691	3600	-	-	1.091	No otoliths collected
65	436	850	M	9	1.026	
66	685	3700	-	-	1.151	No otoliths collected
67	576	2050	-	-	1.073	No otoliths collected
68	575	2400	M	13	1.262	
69	679	3900	M	14	1.246	
70	539	1350	-	-	0.862	No otoliths collected
71	568	2100	-	-	1.146	No otoliths collected
72	565	1800	-	-	0.998	No otoliths collected
73	342	400	F	13	1.000	
74	475	1100	M	-	1.026	No otoliths collected
75	589	2450	M	14	1.199	Otoliths unreadable
76	647	3100	M	15	1.145	
77	647	3200	-	-	1.182	No otoliths collected
78	540	1700	-	-	1.080	No otoliths collected
79	555	2000	-	-	1.170	No otoliths collected
80	668	3300	-	-	1.107	No otoliths collected
81	607	2500	-	-	1.118	No otoliths collected
82	554	1650	-	-	0.970	No otoliths collected
83	614	2700	-	-	1.166	No otoliths collected
84	294	200	F	-	0.787	No otoliths collected
N1	578	2000	F	20	1.036	
N2	596	2600	M	-	1.228	No otoliths collected
N3	592	2300	F	13	1.109	
N4	531	1700	F	13	1.135	
N5	587	2200	M	13	1.088	
N6	587	2400	F	17	1.187	
N7	627	2800	M	14	1.136	
N8	561	1900	F	14	1.076	
N9	730	4500	M	19	1.157	

Appendix 3. Continued.

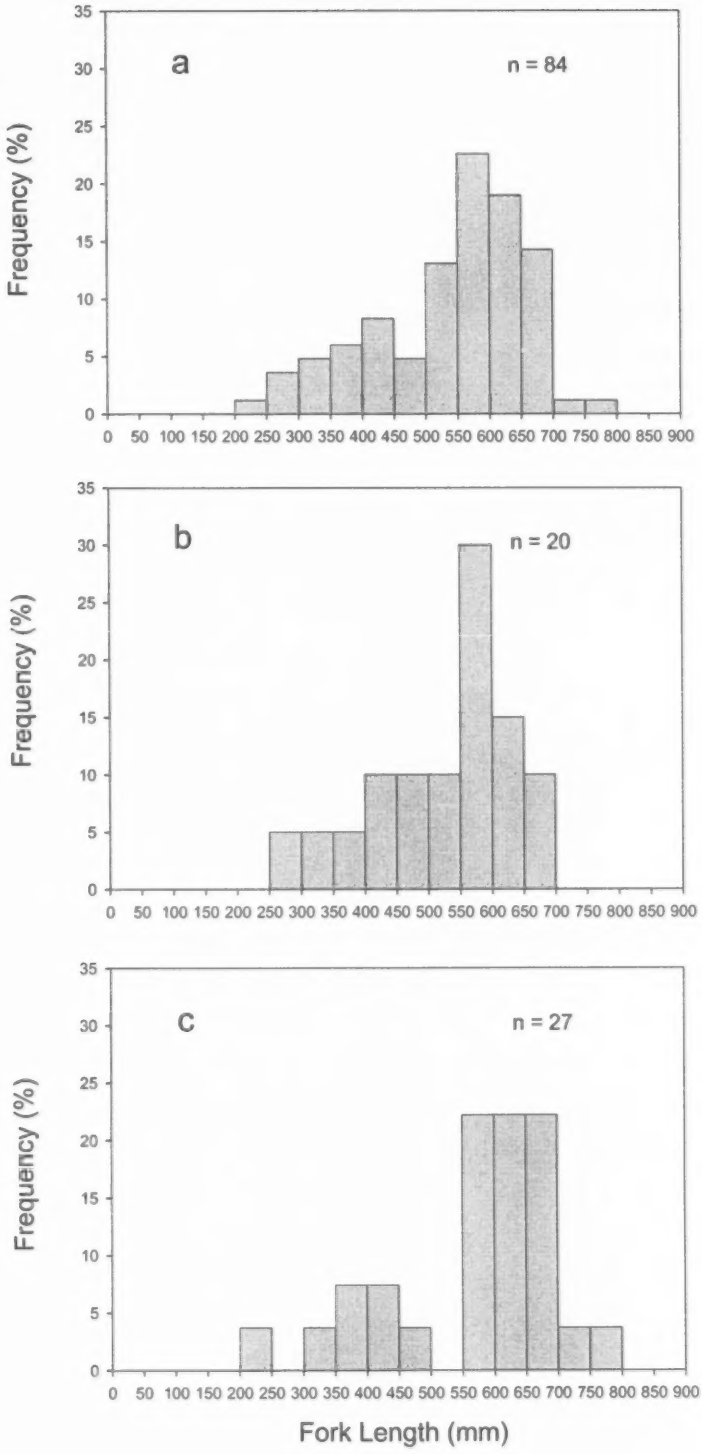
Field Sample No.	Fork Length (mm)	Weight (g)	Sex	Age (yr+)	Condition Factor (K)	Comments
N10	608	2800	M	16	1.246	
N11	553	2250	F	13	1.330	
N12	530	1750	-	13	1.175	
N13	556	2050	M	14	1.193	
N14	526	1900	-	15	1.306	
N15	627	3100	M	14	1.258	
N16	405	650	M	9	0.978	
N17	607	2350	M	13	1.051	
N18	215	100	M	24	1.006	
N19	658	3100	M	-	1.088	Otoliths unreadable
N20	656	2900	M	16	1.027	
N21	622	2700	M	14	1.122	
N22	548	1900	-	18	1.155	
N23	617	2750	F	15	1.171	
N24	624	-	F	18	-	

Appendix 4. Biological data by length interval for Arctic char angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002.

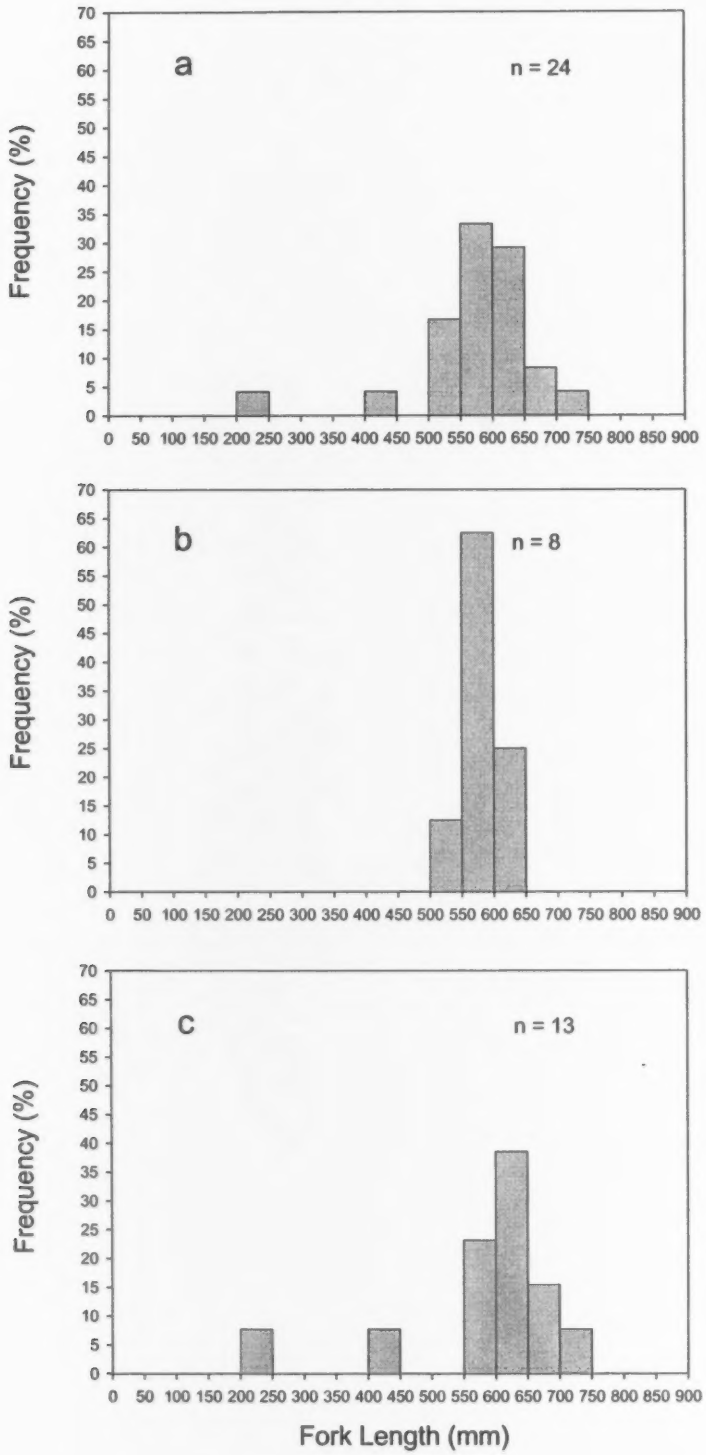
Length Interval (mm)	Males						Females						All Fish					
		Length (mm)		Weight (g)				Length (mm)		Weight (g)				Length (mm)		Weight (g)		
	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K
150	-	-	-	-	-	-	-	-	-	-	-	-	1	193	-	60	-	0.83
200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-	-	-	-	-	-	1	267	-	180	-	0.95
300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
350	2	376	18	525	49	0.99	3	381	16	563	67	1.02	6	377	14	538	56	1.00
400	9	429	15	779	123	0.99	6	434	14	820	104	1.00	15	431	14	795	114	0.99
450	7	479	14	1113	203	1.01	9	472	19	1147	177	1.09	16	475	17	1132	183	1.06
500	5	523	17	1494	216	1.04	19	521	14	1489	183	1.05	24	521	14	1490	185	1.05
550	7	583	12	1963	229	0.99	13	574	15	2006	246	1.06	20	577	14	1991	235	1.04
600	5	625	14	2584	149	1.06	4	624	13	2533	340	1.04	9	624	13	2561	235	1.05
650	3	676	3	3303	131	1.07	1	650	-	3780	-	1.38	4	669	13	3423	261	1.14
700	3	723	20	3660	455	0.97	-	-	-	-	-	-	3	723	20	3660	455	0.97
750	1	761	-	4320	-	0.98	-	-	-	-	-	-	1	761	-	4320	-	0.98
Total	42						55						100					
Mean		541	105	1790	1043	1.01		518	65	1549	626	1.06		521	95	1611	859	1.03

Appendix 5. Biological data by length interval for Arctic char captured at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004.

Length Interval (mm)	Males						Females						All Fish					
		Length (mm)		Weight (g)				Length (mm)		Weight (g)				Length (mm)		Weight (g)		
	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K
200	2	224	13	100	0	0.90	-	-	-	-	-	-	2	224	13	100	0	0.90
250	-	-	-	-	-	-	1	294	-	200	-	0.79	3	287	10	217	29	0.92
300	1	315	-	250	-	0.80	1	342	-	400	-	1.00	4	329	11	325	65	0.91
350	2	361	3	475	35	1.01	1	389	-	500	-	0.85	5	369	13	480	27	0.96
400	3	416	17	700	132	0.96	2	418	14	658	131	0.89	8	416	11	699	98	0.97
450	1	475	-	1100	-	1.03	2	477	6	1100	141	1.01	4	470	14	1075	96	1.04
500	-	-	-	-	-	-	3	526	23	1650	278	1.13	15	532	14	1663	183	1.10
550	9	575	16	2239	295	1.17	11	576	19	2100	343	1.10	27	572	16	2109	304	1.12
600	11	627	16	2875	289	1.16	5	617	16	2538	591	1.08	23	622	16	2764	372	1.14
650	8	665	11	3325	433	1.13	2	664	13	3250	354	1.11	14	670	14	3400	384	1.13
700	2	725	7	3950	778	1.03	-	-	-	-	-	-	2	725	7	3850	778	1.03
750	1	757	-	4450	-	1.03	-	-	-	-	-	-	1	757	-	4450	-	1.03
Total	40						28						108					
Mean		570	131	2371	1200	1.10		541	95	1826	872	1.05		546	115	2022	1069	1.08



Appendix 6. Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males angled from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.



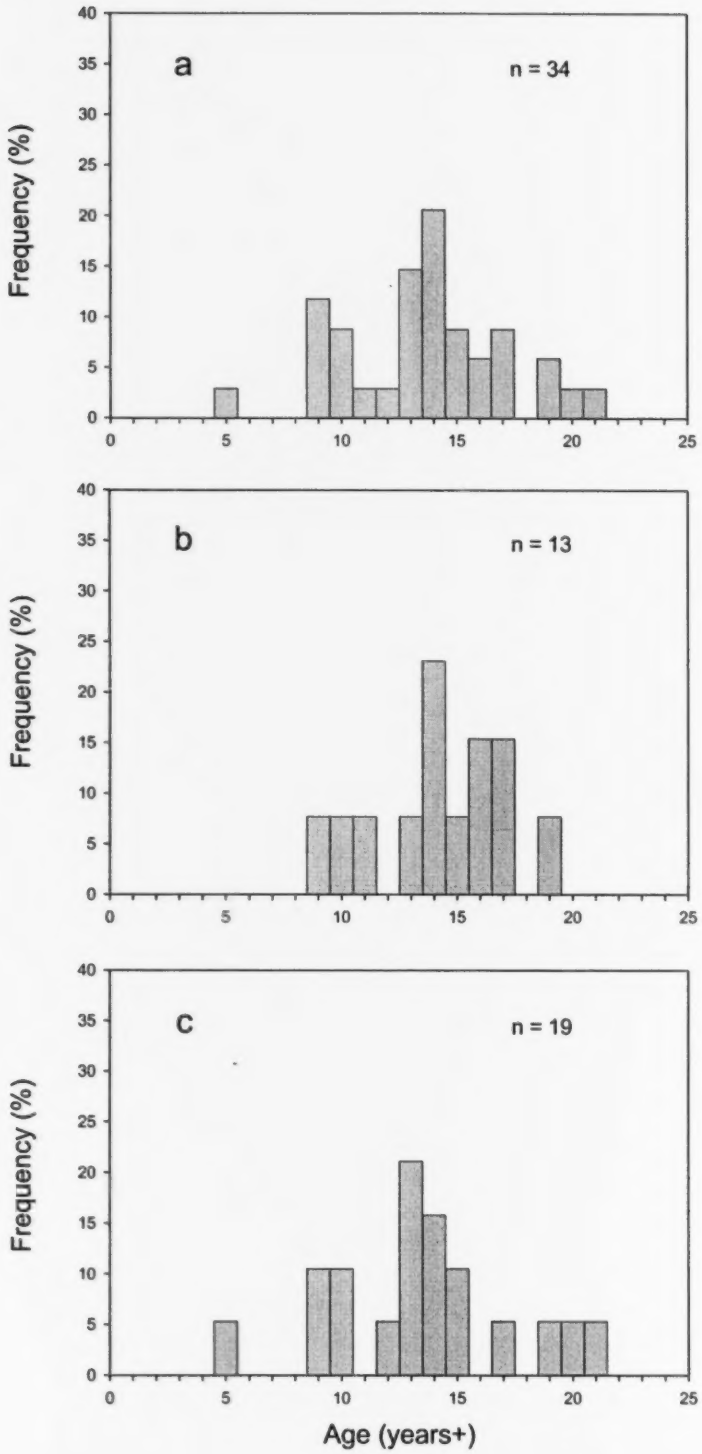
Appendix 7. Length-frequency distributions for Arctic char (a) all fish, (b) females and (c) males gillnetted from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.

Appendix 8. Biological data by age group for Arctic char angled at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 25-27, 2002.

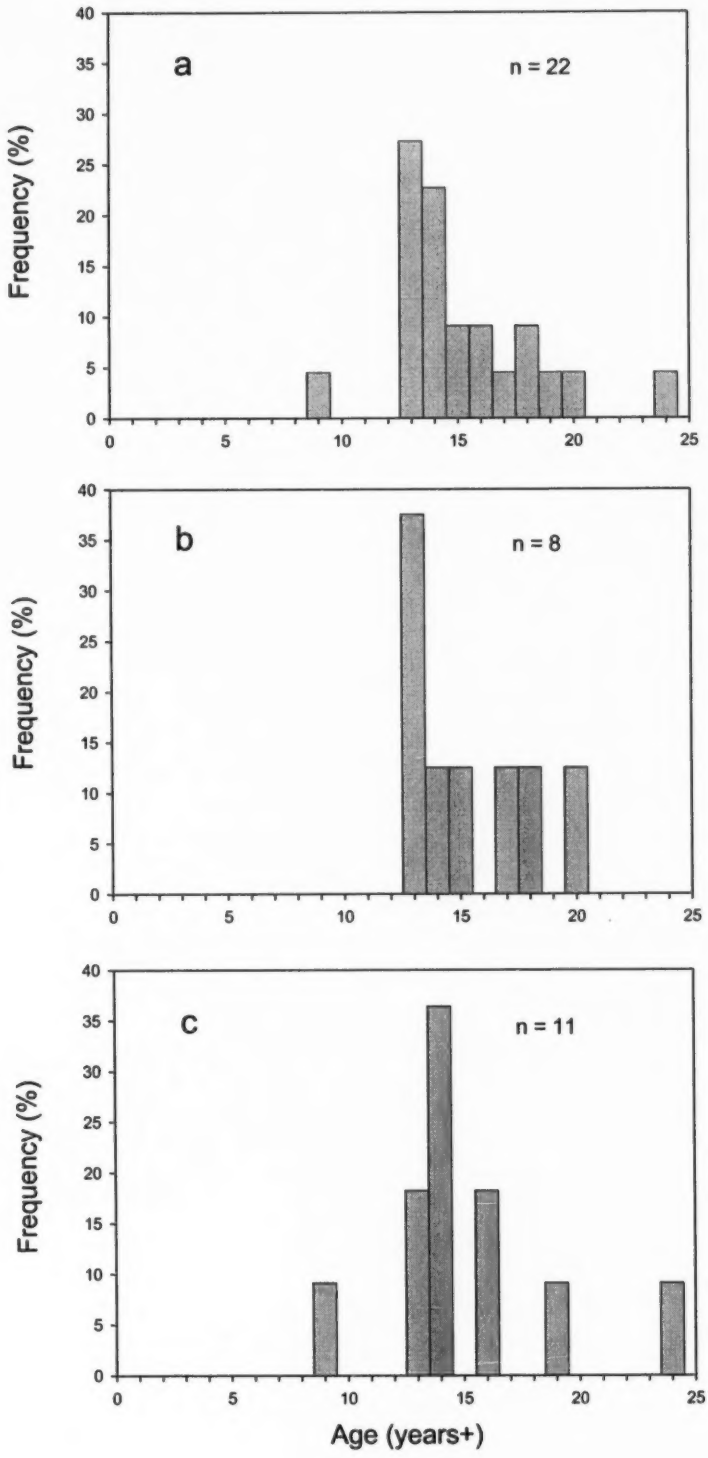
Age (yr+)	Males						Females						All Fish					
	N	Length (mm) Mean	SD	Weight (g) Mean	SD	K	N	Length (mm) Mean	SD	Weight (g) Mean	SD	K	N	Length (mm) Mean	SD	Weight (g) Mean	SD	K
6	-	-	-	-	-	-	-	-	-	-	-	-	1	193	-	60	-	0.83
7	1	389	-	560	-	0.95	-	-	-	-	-	-	2	328	86	370	269	1.05
8	1	406	-	690	-	1.03	-	-	-	-	-	-	1	406	-	690	-	1.03
9	2	425	18	675	49	0.88	2	437	21	735	134	0.88	4	431	18	705	90	0.88
10	3	412	43	733	214	1.05	3	434	60	937	382	1.15	7	416	48	786	302	1.09
11	4	474	54	1033	402	0.97	6	491	35	1235	238	1.04	10	484	41	1154	310	1.02
12	11	530	65	1624	555	1.09	14	494	43	1330	388	1.10	25	510	55	1459	492	1.10
13	3	542	50	1590	392	1.00	10	536	28	1634	323	1.06	13	537	32	1624	323	1.05
14	3	587	70	2210	756	1.09	3	531	80	1730	651	1.16	6	549	74	1970	684	1.19
15	1	622	-	2590	-	1.08	4	588	62	2345	1017	1.15	5	594	56	2394	888	1.14
16	1	673	-	3200	-	1.05	2	590	13	1845	573	0.90	3	617	49	2297	881	0.98
17	1	716	-	4110	-	1.12	3	593	31	2303	447	1.10	4	624	67	2755	974	1.13
18	1	707	-	3670	-	1.04	-	-	-	-	-	-	1	707	-	3670	-	1.04
19	1	761	-	4320	-	0.98	-	-	-	-	-	-	1	761	-	4320	-	0.98
20	1	643	-	2700	-	1.02	-	-	-	-	-	-	1	643	-	2700	-	1.02
21	2	711	49	3230	42	0.90	-	-	-	-	-	-	2	711	49	3230	42	0.90
Total	36						47						86					
Mean		543	109	1812	1070	1.13		517	60	1528	598	1.11		519	97	1602	868	1.15
Mean Age				13.0						12.7						12.6		

Appendix 9. Biological data by age group for Arctic char captured at Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 22-24, 2004.

Age (yr+)	Males						Females						All Fish					
		Length (mm)		Weight (g)				Length (mm)		Weight (g)				Length (mm)		Weight (g)		
	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K	N	Mean	SD	Mean	SD	K
5	1	233	-	100	-	0.79	-	-	-	-	-	-	1	233	-	100	-	0.79
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	3	385	63	583	306	0.93	1	389		500		0.85	5	392	46	580	222	0.91
10	2	361	3	475	35	1.01	1	428		750		0.96	3	383	39	567	161	0.99
11	-	-	-	-	-	-	1	500		1350		1.08	1	500	-	1350	-	1.08
12	1	624	-	-	-	-	-	-	-	-	-	-	1	624	-	-	-	-
13	6	586	31	2275	322	1.13	4	505	111	1663	884	1.14	11	551	76	2005	619	1.14
14	7	625	44	2993	714	1.20	4	589	40	2125	727	1.02	12	611	42	2667	773	1.14
15	2	664	23	3300	283	1.13	2	608	13	2475	389	1.10	5	614	58	2690	650	1.15
16	2	632	34	2850	71	1.14	2	624	44	2900	849	1.17	4	628	32	2875	492	1.16
17	1	654	-	2800	-	1.00	3	581	21	2100	608	1.05	4	600	40	2275	608	1.04
18	-	-	-	-	-	-	1	624	-	-	-	-	2	586	54	1900	-	1.15
19	2	725	7	3950	778	1.03	1	560	-	2250	-	1.28	3	670	95	3383	1125	1.12
20	1	757	-	4450	-	1.03	1	578	-	2000	-	1.04	2	668	127	3225	1732	1.03
21	1	658	-	3100	-	1.09	-	-	-	-	-	-	1	658	-	3100	-	1.09
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	1	215	-	100	-	1.01	-	-	-	-	-	-	1	215	-	100	-	1.01
Total	30						21						56					
Mean		565	144	2347	1289	1.09		555	80	1953	808	1.08		558	117	2145	1095	1.09
Mean Age				14.1						14.7						14.3		



Appendix 10. Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males angled from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.



Appendix 11. Age-frequency distributions for Arctic char (a) all fish, (b) females and (c) males gillnetted from Nalusiaq Lake, Auyuittuq National Park, Nunavut, May 2004.